BALDOR

NextMove ESB-2

Motion Controller

Installation manual

MN1957 9/10

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Safety Notice

Only qualified personnel should attempt to start-up, program or troubleshoot this equipment. This equipment may be connected to other machines that have rotating parts or parts that are controlled by this equipment. Improper use can cause serious or fatal injury.

Precautions

Do not touch any circuit board, power device or electrical connection before you first ensure that no high voltage is present at this equipment or other equipment to which it is connected. Electrical shock can cause serious or fatal injury. Only qualified personnel should attempt to start-up, program or troubleshoot this equipment.

Be sure that you are completely familiar with the safe operation and programming of this equipment. This equipment may be connected to other machines that have rotating parts or parts that are controlled by this equipment. Improper use can cause serious or fatal injury.

MEDICAL DEVICE / PACEMAKER DANGER: Magnetic and electromagnetic fields in the vicinity of current carrying conductors and industrial motors can result in a serious health hazard to persons with cardiac pacemakers, internal cardiac defibrillators, neurostimulators, metal implants, cochlear implants, hearing aids, and other medical devices. To avoid risk, stay away from the area surrounding a motor and its current carrying conductors.

The stop input to this equipment should not be used as the single means of achieving a safety critical stop. Drive disable, motor disconnect, motor brake and other means should be used as appropriate.

Improper operation or programming may cause violent motion of the motor shaft and driven equipment. Be certain that unexpected motor shaft movement will not cause injury to personnel or damage to equipment. Peak torque of several times the rated motor torque can occur during control failure.

The safe integration of this equipment into a machine system is the responsibility of the machine designer. Be sure to comply with the local safety requirements at the place where the machine is to be used. In Europe these are the Machinery Directive, the ElectroMagnetic Compatibility Directive and the Low Voltage Directive. In the United States this is the National Electrical code and local codes.

Electrical components can be damaged by static electricity. Use ESD (electrostatic discharge) procedures when handling this equipment.

2.1 NextMove ESB-2 features

NextMove ESB-2 is a high performance multi-axis intelligent controller for servo and stepper motors.

NextMove ESB-2 features the Mint motion control language. Mint is a structured form of Basic, custom designed for stepper or servo motion control applications. It allows you to get started very quickly with simple motion control programs. In addition, Mint includes a wide range of powerful commands for complex applications.

Standard features include:

- Control of 4 stepper axes and either 3 or 4 servo axes (model dependent).
- Additional encoder input for master follower applications.
- A wide variety of motion types including point to point moves, software cams and gearing.
- 20 general purpose digital inputs, software configurable as level or edge triggered.
- 12 general purpose digital outputs.
- 2 differential analog inputs with 12-bit resolution.
- 4 single-ended analog outputs with 12-bit resolution.
- USB serial port.
- CANopen protocol for communication with Mint controllers and other third party CANopen devices.
- Programmable in Mint.
- Drop-in replacement for NextMove ESB.

Included with NextMove ESB-2 is the Mint Motion Toolkit CD. This contains a number of utilities and useful resources to get the most from your Mint controller. These include:

- Mint WorkBench
  This is the user interface for communicating with the NextMove ESB-2.

- PC Developer Libraries
  Installing Mint WorkBench will install ActiveX interfaces that allow PC applications to be written that communicate with the NextMove ESB-2.

This manual is intended to guide you through the installation of NextMove ESB-2.

The chapters should be read in sequence.

The *Basic Installation* section describes the mechanical installation of the NextMove ESB-2. The following sections require knowledge of the low level input/output requirements of the installation and an understanding of computer software installation. If you are not qualified in these areas you should seek assistance before proceeding.

Note: You can check that you have the latest firmware and Mint WorkBench releases by visiting the website www.baldormotion.com.

2.2 Receiving and inspection

When you receive your NextMove ESB-2, there are several things you should do immediately:

1. Check the condition of the shipping container and report any damage immediately to the carrier that delivered your NextMove ESB-2.
2. Remove the NextMove ESB-2 from the shipping container and remove all packing material. The container and packing materials may be retained for future shipment.
3. Verify that the catalog number of the NextMove ESB-2 you received is the same as the catalog number listed on your purchase order. The catalog number is described in the next section.
4. Inspect the NextMove ESB-2 for external damage during shipment and report any damage to the carrier that delivered your NextMove ESB-2.
5. If NextMove ESB-2 is to be stored for several weeks before use, be sure that it is stored in a location that conforms to the storage humidity and temperature specifications shown in section 7.1.11.

2.2.1 Identifying the catalog number

Different models of NextMove ESB-2 are available. As a reminder of which product has been installed, it is a good idea to write the catalog number in the space provided below.

Catalog number: **NSB**_____

Installed at: _____ **Date:** _____

A description of the catalog numbers are show in the following table:

Catalog number	Description	Serial port	Stepper output type
NSB202-501	3 servo axes, 4 stepper axes, 2 extra encoder inputs	RS232	Differential
NSB202-502	3 servo axes, 4 stepper axes, 2 extra encoder inputs	RS485	
NSB203-501	3 servo axes, 4 stepper axes, 2 extra encoder inputs	RS232	Open collector
NSB203-502	3 servo axes, 4 stepper axes, 2 extra encoder inputs	RS485	
NSB204-501	4 servo axes, 4 stepper axes, 1 extra encoder input	RS232	Differential
NSB204-502	4 servo axes, 4 stepper axes, 1 extra encoder input	RS485	
NSB205-501	4 servo axes, 4 stepper axes, 1 extra encoder input	RS232	Open collector
NSB205-502	4 servo axes, 4 stepper axes, 1 extra encoder input	RS485	

2.3 Units and abbreviations

The following units and abbreviations are used in this manual:

V. . . . . Volt (also VAC and VDC)
W . . . . . Watt
A. . . . . Ampere
Ω . . . . . Ohm
µF. . . . . microfarad
pF. . . . . picofarad
mH . . . . . millihenry

Φ . . . . . phase
ms . . . . . millisecond
µs . . . . . microsecond
ns . . . . . nanosecond

mm . . . . . millimeter
m . . . . . meter
in . . . . . inch
ft. . . . . feet
lbf-in . . . . . pound force inch (torque)
N·m . . . . . Newton meter (torque)

ADC . . . . . Analog to Digital Converter
ASCII . . . . . American Standard Code for Information Interchange
AWG . . . . . American Wire Gauge
CAL . . . . . CAN Application Layer
CAN . . . . . Controller Area Network
CDROM . . . . . Compact Disc Read Only Memory
CiA . . . . . CAN in Automation International Users and Manufacturers Group e.V.
CTRL+E . . . . . on the PC keyboard, press Ctrl then E at the same time.
DAC . . . . . Digital to Analog Converter
DS301 . . . . . CiA CANopen Application Layer and Communication Profile
DS401 . . . . . CiA Device Profile for Generic I/O Devices
DS402 . . . . . CiA Device Profile for Drives and Motion Control
DS403 . . . . . CiA Device Profile for HMIs
EDS . . . . . Electronic Data Sheet
EMC. . . . . Electromagnetic Compatibility
HMI . . . . . Human Machine Interface
ISO. . . . . International Standards Organization
Kbaud. . . . . kilobaud (the same as Kbit/s in most applications)
LCD . . . . . Liquid Crystal Display
Mbps . . . . . megabits/s
MB . . . . . megabytes
MMC . . . . . Mint Machine Center
(NC) . . . . . Not Connected
RF . . . . . Radio Frequency
SSI . . . . . Synchronous Serial Interface
TCP/IP . . . . . Transmission Control Protocol / Internet Protocol
UDP . . . . . User Datagram Protocol

3.1 Introduction

You should read all the sections in Basic Installation to ensure safe installation.
It is important that the correct steps are followed when installing the NextMove ESB-2. This section describes the mechanical installation of the NextMove ESB-2.

3.1.1 Location requirements

You must read and understand this section before beginning the installation.

CAUTION

To prevent equipment damage, be certain that input and output signals are powered and referenced correctly.

CAUTION

To ensure reliable performance of this equipment be certain that all signals to/ from the NextMove ESB-2 are shielded correctly.

CAUTION

Avoid locating the NextMove ESB-2 immediately above or beside heat generating equipment, or directly below water steam pipes.

CAUTION

Avoid locating the NextMove ESB-2 in the vicinity of corrosive substances or vapors, metal particles and dust.

The safe operation of this equipment depends upon its use in the appropriate environment. The following points must be considered:

- The NextMove ESB-2 is designed to be mounted indoors, permanently fixed and located.
- The NextMove ESB-2 must be secured by the slots in the metal case.
- The NextMove ESB-2 must be installed in an ambient temperature of 0 °C to 45 °C (32 °F to 113 °F).
- The NextMove ESB-2 must be installed in relative humidity levels of less than 80% for temperatures up to 31 °C (87 °F) decreasing linearly to 50% relative humidity at 45 °C (113 °F), non-condensing.
- The NextMove ESB-2 must be installed where the pollution degree according to IEC664 shall not exceed 2.
- There shall not be abnormal levels of nuclear radiation or X-rays.

3.1.2 Mounting the NextMove ESB-2

CAUTION

Before touching the unit be sure to discharge static electricity from your body and clothing by touching a grounded metal surface. Alternatively, wear an earth strap while handling the unit.

Ensure you have read and understood the location requirements in section 3.1.1. Mount the NextMove ESB-2 using the supplied M4 screws. For effective cooling, the NextMove ESB-2 must be mounted on a smooth non-flammable vertical surface. Orientation must be as shown in Figure 1, with the two slots in the metal carrier / heat sink assembly at the bottom.

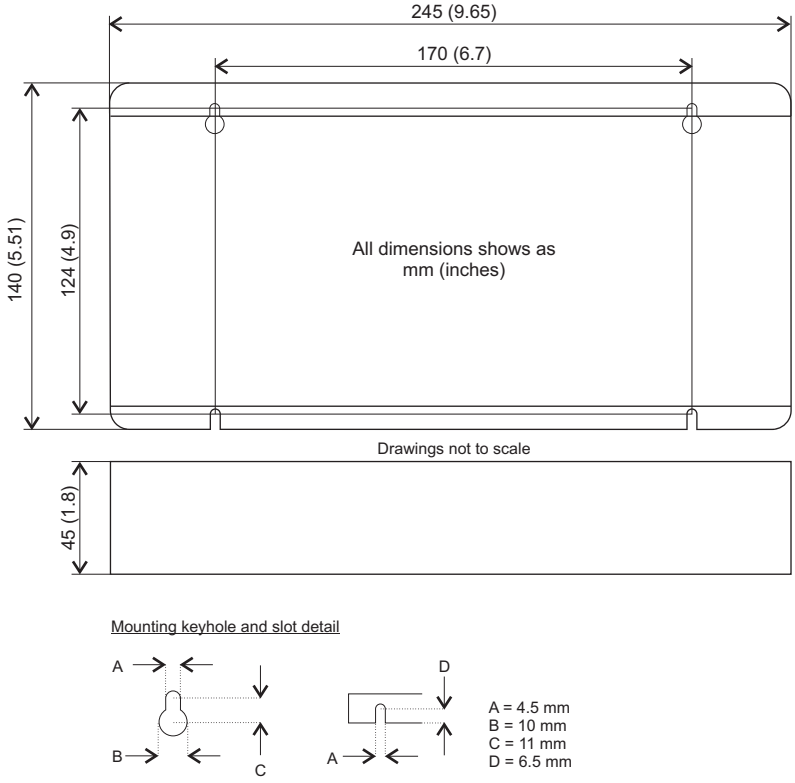


Figure 1: Package dimensions

There must be at least 20 mm (0.8 in) clearance between the NextMove ESB-2 and neighboring equipment to allow sufficient cooling by natural convection. Remember to allow additional space around the edges to accommodate the mating connectors and associated wiring. For example, 70 mm (2.8 in) clearance will be required for connection of the serial port cable.

3.1.3 Other requirements for installation

The components you will need to complete the basic installation are:

- The NextMove ESB-2 requires +24 V power supply capable of supplying 2 A continuously. It is recommended that a separate fused 24 V supply is provided for the NextMove ESB-2, with the fuse rated at 4 A maximum. If digital outputs are to be used, a supply will be required to drive them - see section 4.3.2.
- A PC that fulfils the following specification:

	Minimum specification	Recommended specification
Processor	Intel PentiumIII 500 MHz	Intel PentiumIII / 4 or equivalent 1 GHz or faster
RAM	128 MB	1 GB
Hard disk space	50 MB	50 MB
CD-ROM	A CD-ROM drive	
Communication	USB port or RS232 / RS485/422 serial port	
Screen	1024 x 768, 16-bit color	1152 x 864, 16-bit color
Mouse	A mouse or similar pointing device	
Operating system	Windows 2000, Windows XP or Windows Vista	

- A USB cable (supplied), or RS485/422 serial cable (not supplied).
- The PC operating system user manual, if you are not familiar with Windows.

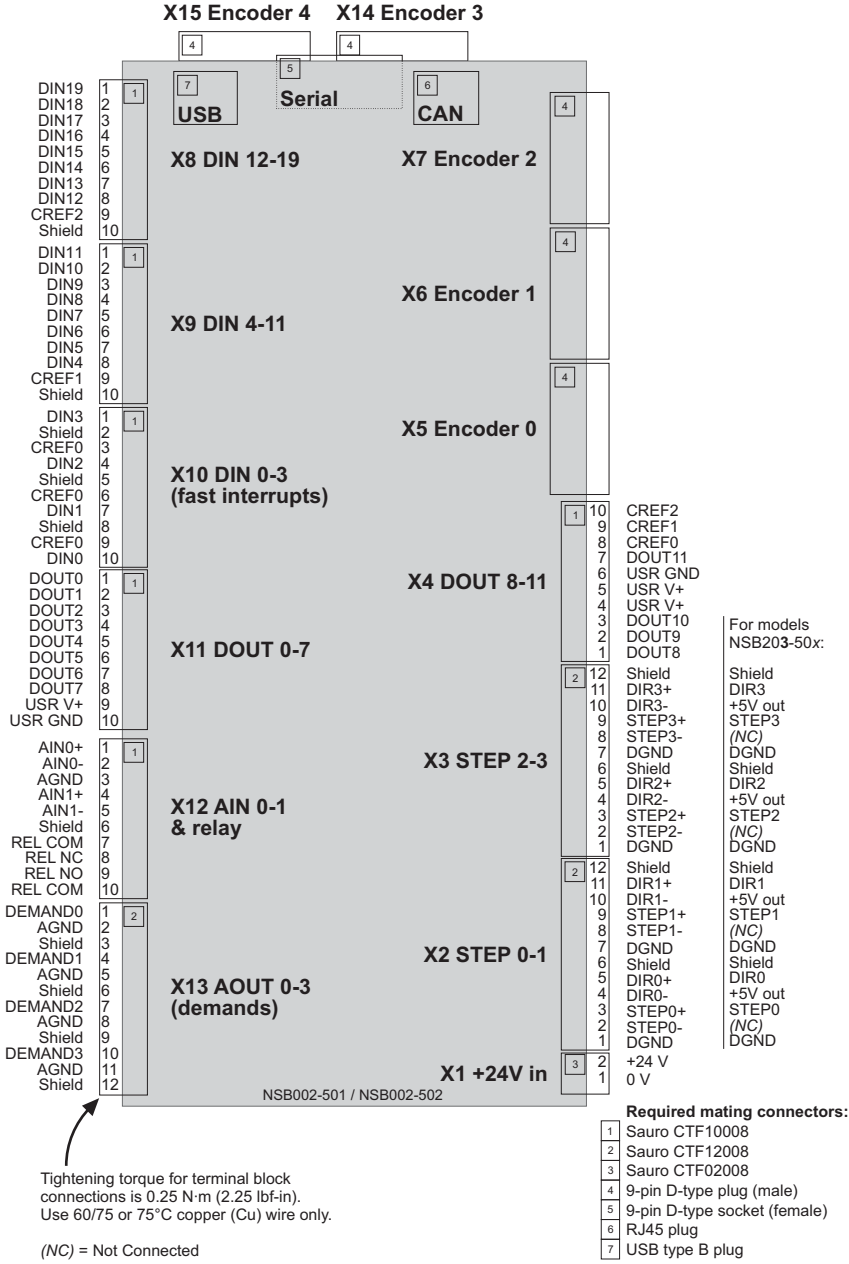
4.1 Introduction

This section describes the input and output capabilities of the NextMove ESB-2.

The following conventions will be used to refer to the inputs and outputs:

I/O . . . . . Input / Output
DIN . . . . . Digital Input
DOUT . . . . . Digital Output
AIN . . . . . Analog Input
AOUT . . . . . Analog Output

4.1.1 Connector locations


X15 Encoder 4
X14 Encoder 3
USB
Serial
CAN
X8 DIN 12-19
X7 Encoder 2
X6 Encoder 1
X9 DIN 4-11
X5 Encoder 0
X10 DIN 0-3
(fast interrupts)
X4 DOUT 8-11
X11 DOUT 0-7
X3 STEP 2-3
X12 AIN 0-1
& relay
X2 STEP 0-1
X13 AOUT 0-3
(demands)
X1 +24V in
NSB002-501 / NSB002-502
DIN19 DIN18 DIN17 DIN16 DIN15 DIN14 DIN13 DIN12 CREF2 Shield
DIN11 DIN10 DIN9 DIN8 DIN7 DIN6 DIN5 DIN4 CREF1 Shield
DIN3 Shield CREF0 DIN2 Shield CREF0 DIN1 Shield CREF0 DIN0
DOUT0 DOUT1 DOUT2 DOUT3 DOUT4 DOUT5 DOUT6 DOUT7 USR V+ USR GND
AIN0+ AIN0- AGND AIN1+ AIN1- Shield REL COM REL NC REL NO REL COM
DEMAND0 AGND Shield DEMAND1 AGND Shield DEMAND2 AGND Shield DEMAND3 AGND Shield
CREF2 CREF1 CREF0 DOUT11 USR GND USR V+ USR V+ DOUT10 DOUT9 DOUT8
Shield DIR3+ DIR3- STEP3+ STEP3- DGND Shield DIR2+ DIR2- STEP2+ STEP2- DGND
Shield DIR1+ DIR1- STEP1+ STEP1- DGND Shield DIR0+ DIR0- STEP0+ STEP0- DGND
+24 V
0 V
For models NSB203-50x:
Shield DIR3 +5V out STEP3 (NC) DGND Shield DIR2 +5V out STEP2 (NC) DGND
Shield DIR1 +5V out STEP1 (NC) DGND Shield DIR0 +5V out STEP0 (NC) DGND

Tightening torque for terminal block connections is 0.25 N·m (2.25 lbf-in). Use 60/75 or 75°C copper (Cu) wire only.

(NC) = Not Connected

Required mating connectors:

1. Sauro CTF10008
2. Sauro CTF12008
3. Sauro CTF02008
4. 9-pin D-type plug (male)
5. 9-pin D-type socket (female)
6. RJ45 plug
7. USB type B plug

4.2 Analog I/O

The NextMove ESB-2 provides:

- Two 12-bit resolution analog inputs.
- Four 12-bit resolution analog outputs.

4.2.1 Analog inputs

The analog inputs are available on connector X12, pins 1 & 2 (AIN0) and 4 & 5 (AIN1).

- Differential inputs.
- Voltage range: ±10 V.
- Resolution: 12-bit with sign.
- Input impedance: 120 kΩ.
- Sampling frequency: 4 kHz maximum, 2 kHz if both inputs are enabled.

The analog inputs pass through a differential buffer and second order low-pass filter with a cut-off frequency of approximately 1 kHz.

Both inputs are normally sampled at 2 kHz. However, an input can be disabled by setting ADCMODE to 4 (_acOFF). With one input disabled, the remaining input will be sampled at 4 kHz. In Mint, analog inputs can be read using the ADC keyword. See the Mint help file for full details of ADC, ADCMODE and other related ADC... keywords.

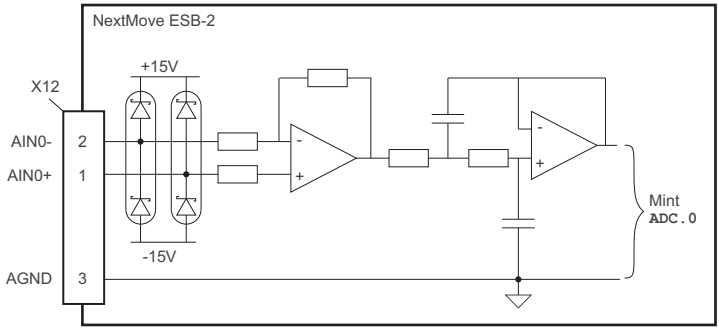


Figure 2: Analog input, AIN0 shown

For differential inputs connect input lines to AIN+ and AIN-. Leave AGND unconnected.

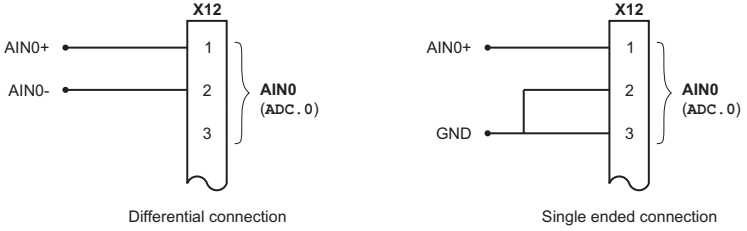


Figure 3: AIN0 analog input wiring

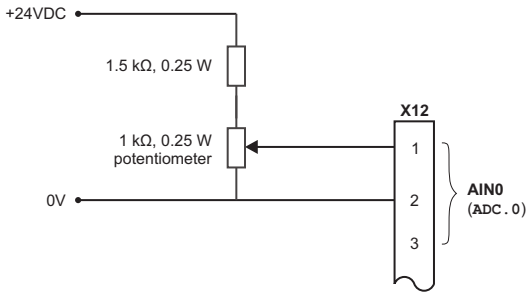


Figure 4: Typical input circuit to provide 0-10 V (approx.) input from a 24 V source

4.2.2 Analog outputs

The four analog outputs are available on connector X13, as shown in section 4.1.1.

- Four independent bipolar analog outputs.
- Output range: ±10 VDC (±0.1%).
- Resolution: 12-bit.
- Output current: 2.5 mA maximum per output.
- Update frequency: 10 kHz maximum (adjustable using the `LOOPTIME` keyword, factory default 1 kHz).

Mint and the Mint Motion Library use analog outputs Demand0 to Demand3 to control drive amplifiers. Demand outputs 0 to 3 are used by axes configured as servo (see section 5.4.1). A Demand output may be used as a general purpose analog output if it is not assigned to a servo axis - see the `DAC` keyword in the Mint help file.

The analog outputs may be used to drive loads of 4 kΩ or greater. Shielded twisted pair cable should be used. The shield connection should be made at one end only.

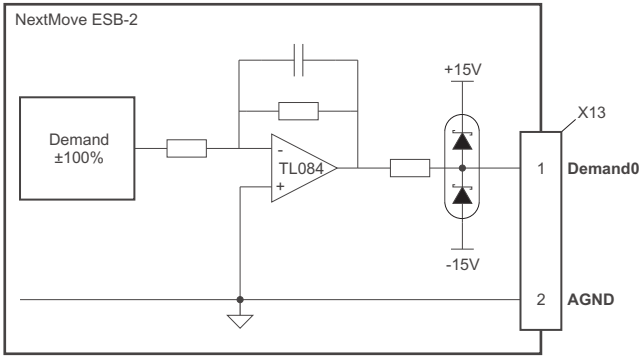


Figure 5: Analog output, Demand0 shown

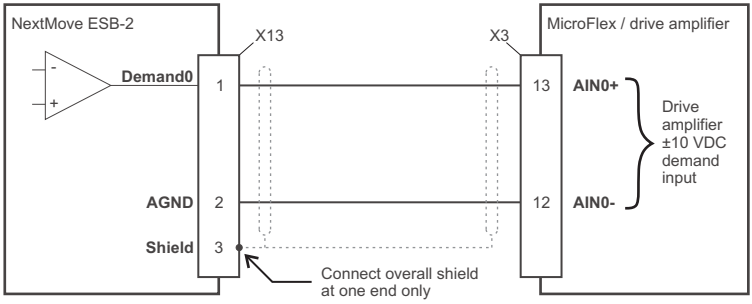


Figure 6: Analog output - typical connection to Baldor MicroFlex

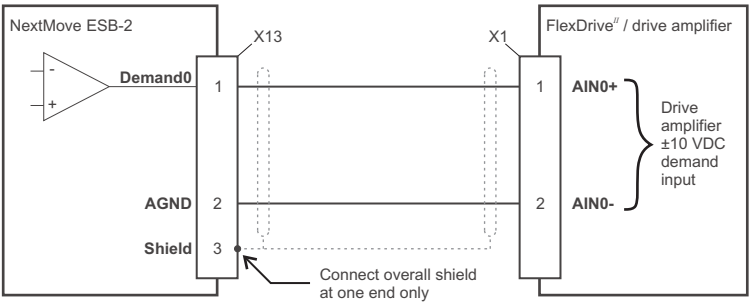


Figure 7: Analog output - typical connection to Baldor FlexDrive^{II}, Flex+Drive^{II}, MintDrive^{II}

4.3 Digital I/O

The NextMove ESB-2 provides:

- 20 general purpose digital inputs.
- 12 general purpose digital outputs.

4.3.1 Digital inputs

Digital inputs are available on connectors X8, X9 and X10, as shown in section 4.1.1.
The digital inputs are arranged in three groups, each with their own common connection. This allows each group to be configured independently for 'active high' or 'active low' operation.

The general purpose digital inputs DIN0 - DIN19 can be shared between axes, and are programmable in Mint (using a range of keywords beginning with the letters `INPUT`...) to determine their active level and if they should be edge triggered. The state of individual inputs can be read directly using the `INX` keyword. See the Mint help file.

A general purpose digital input can be assigned to a special purpose function such as a home, limit, stop or error input. See the keywords `HOMEINPUT`, `LIMITFORWARDINPUT`, `LIMITREVERSEINPUT`, `STOPINPUT` and `ERRORINPUT` in the Mint help file.

4.3.1.1 DIN0 - DIN3

Digital inputs DIN0 to DIN3 can be assigned as fast interrupts. These are used as high speed position latches, allowing any combination of axes to be captured by the hardware. The latency between input triggering and capture is 1 µs. Special Mint keywords (beginning with the letters `FAST`...) allow specific functions to be performed as a result of fast position inputs becoming active. See the Mint help file for details. Digital inputs DIN0 to DIN3 use CREF0 as their common connection.

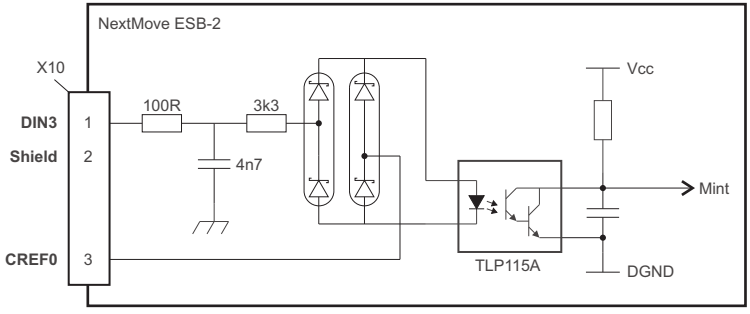


Figure 8: Fast interrupt digital input - DIN3 shown

Note: The fast inputs are particularly sensitive to noise, so inputs must use shielded twisted pair cable. Do not connect mechanical switches, relay contacts or other sources liable to signal 'bounce' directly to the fast inputs. This could cause unwanted multiple triggering.

4.3.1.2 DIN4 - DIN11

Digital inputs DIN4 to DIN11 have a common specification:

- Opto-isolated digital inputs.
- Sampling frequency: 1 kHz.

Digital inputs DIN4 to DIN11 use CREF1 as their common connection.

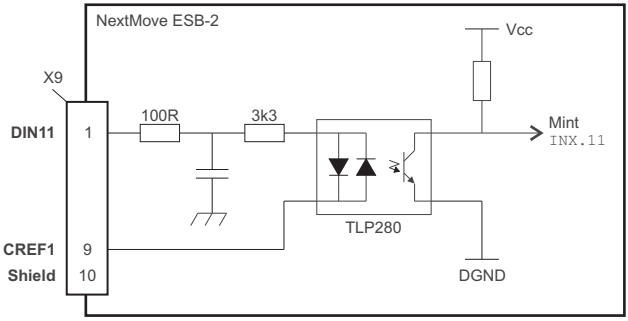


Figure 9: General purpose digital input - DIN11 shown

If an input is configured as edge triggered, the triggering pulse must have a duration of at least 1 ms (one software scan) to guarantee acceptance by Mint. The use of shielded cable for inputs is recommended.

4.3.1.3 DIN12 - DIN19

Digital inputs DIN12 to DIN19 have the same electrical specification as DIN4-11, except that they use CREF2 as their common connection.

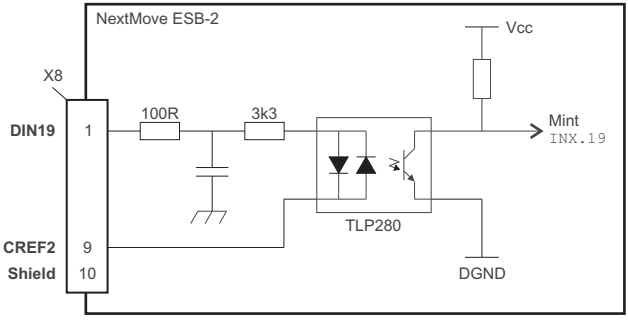


Figure 10: General purpose digital input - DIN19 shown

4.3.1.4 Auxiliary encoder inputs - DIN17 (STEP), DIN18 (DIR), DIN19 (Z)

DIN17-DIN19 may also be used as an auxiliary encoder input. DIN17 accepts step (pulse) signals and DIN18 accepts direction signals, allowing an external source to provide the reference for the speed and direction of an axis. The step frequency (15 kHz maximum) determines the speed, and the direction input determines the direction of motion. Both the rising and falling edges of the signal on DIN17 cause an internal counter to be changed; see Figure 11. If 5 V is applied to DIN18 (or it is left unconnected) the counter will increment. If DIN18 is grounded the counter will be decremented. A minimum period of 500 µs is required between transitions on the direction and step input to guarantee the change of direction has been recognized.

Typically, one channel of an encoder signal (either A or B) is used to provide the step signal on DIN17, allowing the input to be used as an auxiliary (master) encoder input. The input can be used as a master position reference for cam, fly and follow move types. For this, the `MASTERSOURCE` keyword must be used to configure the step input as a master (auxiliary) encoder input. The master position reference can then be read with the `AUXENCODER` keyword (using 0 as the channel parameter). Since a secondary encoder channel is not used, DIN18 allows the direction of motion to be determined. The Z signal on DIN19 can be supplied from the encoder's index signal, and may be read using the `AUXENCODERZLATCH` keyword. See the Mint help file for details of each `AUXENCODER...` keyword.

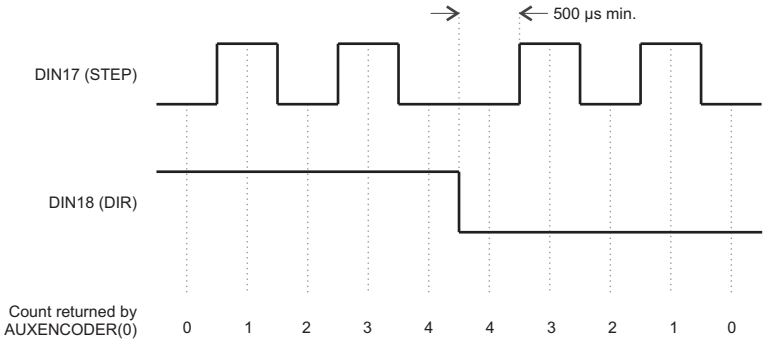


Figure 11: Auxiliary encoder input 0 (DIN17/18) - edge counting

Note that encoder input ENC 4 forms another auxiliary encoder input, using normal incremental encoder connections A, B and Z. This supports a higher frequency input and additional functionality - see section 4.4.3.

4.3.1.5 Typical digital input wiring

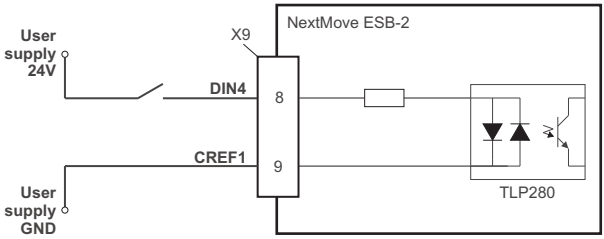


Figure 12: Digital input - typical 'active high' input connection using a switch

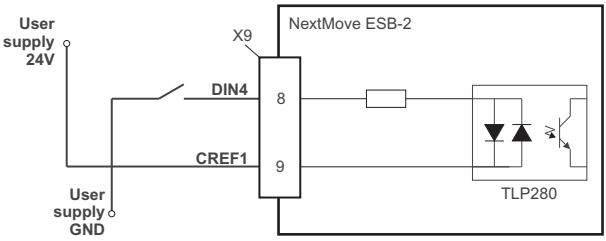


Figure 13: Digital input - typical 'active low' input connection using a switch

Note: The circuits shown in Figures 12 and 13 are not suitable for use with fast inputs DIN0 to DIN3. Using a mechanical switch, relay contacts or other source liable to signal 'bounce' could cause unwanted multiple triggering.

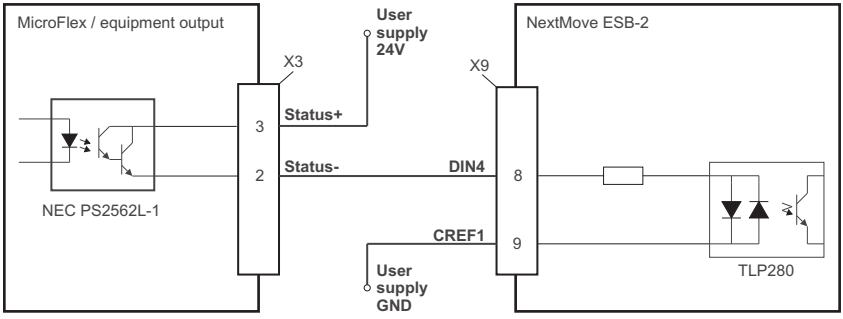


Figure 14: Digital input - typical connections from a Baldor MicroFlex

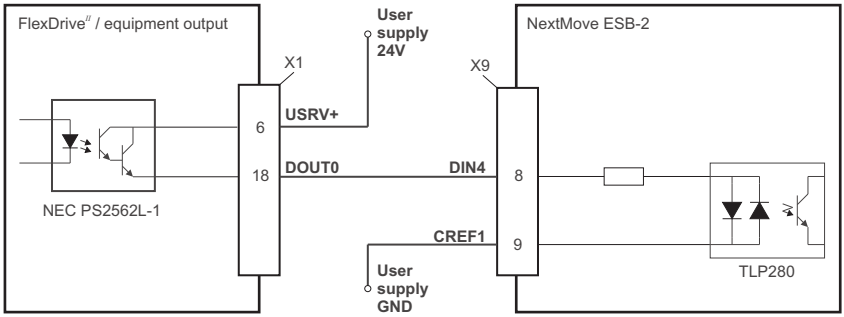


Figure 15: Digital input - typical connections from a Baldor FlexDrive^{II}, Flex+Drive^{II} or MintDrive^{II}

4.3.2 Digital outputs

The digital outputs are available on connectors X4 and X11, as shown in section 4.1.1.
A digital output can be configured in Mint as a general purpose output, a drive enable output or a global error output. Outputs can be shared between axes and can be configured using Mint WorkBench (or the `OUTPUTACTIVELEVEL` keyword) to determine their active level.

4.3.2.1 DOUT0 - DOUT7

An external supply (typically 24 VDC) is used to power the UDN2987 output devices, as shown in Figure 16. When an output is activated, current is sourced from the user supply through a UDN2987 output driver.

- A total of 500 mA may be sourced by DOUT0 - DOUT7, providing an average 62.5 mA per output when all outputs are on (100% duty cycle, 24 V supply).
- An individual output can provide a maximum continuous current of 350 mA, but if other outputs are being used the total current must not exceed 500 mA.
- The maximum allowable power dissipation for the UDN2987 driver is 1.5 W. If this is exceeded the driver may shut down. To reset it, the NextMove ESB-2 must be power cycled.

If an output is used to drive an inductive load such as a relay, a suitably rated diode must be fitted across the relay coil, observing the correct polarity. The use of shielded cable is recommended.

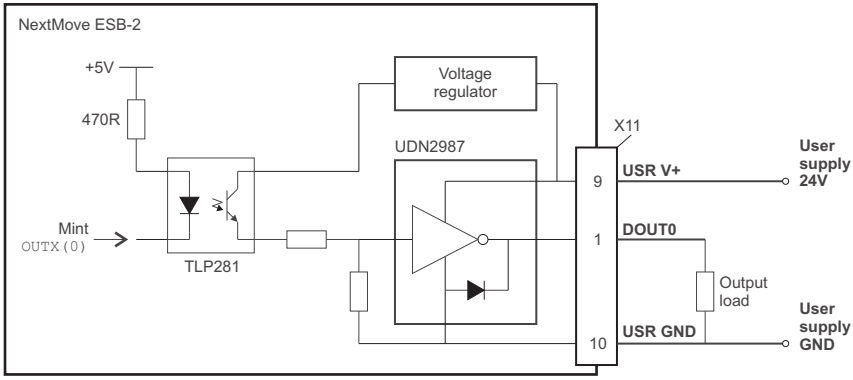


Figure 16: Digital outputs (DOUT0-7) - DOUT0 shown

4.3.2.2 DOUT8 - DOUT11

DOUT8 - DOUT11 use the same type of output circuitry as DOUT0 - DOUT7, with their own UDN2987 output driver. Because only four of the UDN2987's eight outputs are being used, the average current available on DOUT8 - DOUT11 is increased:

- A total of 500 mA may be sourced by DOUT8 - DOUT11, providing an average 125 mA per output when all outputs are on (100% duty cycle, 24 V supply).
- An individual output can provide a maximum continuous current of 350 mA, but if other outputs are being used the total current must not exceed 500 mA.
- The maximum allowable power dissipation for the UDN2987 driver is 1.5 W. If this is exceeded the driver may shut down. To reset it, the NextMove ESB-2 must be power cycled.

4.4 Other I/O

4.4.1 Stepper control outputs - models NSB202... / NSB204...

The stepper control outputs are available on connectors X2 and X3, as shown in section 4.1.1. There are four sets of stepper motor control outputs, operating in the range 0 Hz to 500 kHz. Each of the step (pulse) and direction signals from the NextMove ESB-2 is driven by DS26LS31 line drivers, providing RS422 differential outputs. It is recommended to use separate shielded cables for the step outputs. The shield should be connected at one end only.

The STEPPERDELAY keyword allows a 0 - 4.25 µs delay to be introduced between state changes of the step and direction outputs. The FREQ keyword can be used to directly control the output frequency, between 60 Hz and 500 kHz - see the Mint help file.

CAUTION

The DS26LS31 drivers are static sensitive devices. Take appropriate ESD precautions when handling the NextMove ESB-2. When connecting the outputs to single ended inputs as shown in Figures 17 and 18, do not connect the STEP*x*- or DIR*x*- outputs to ground; leave them unconnected.

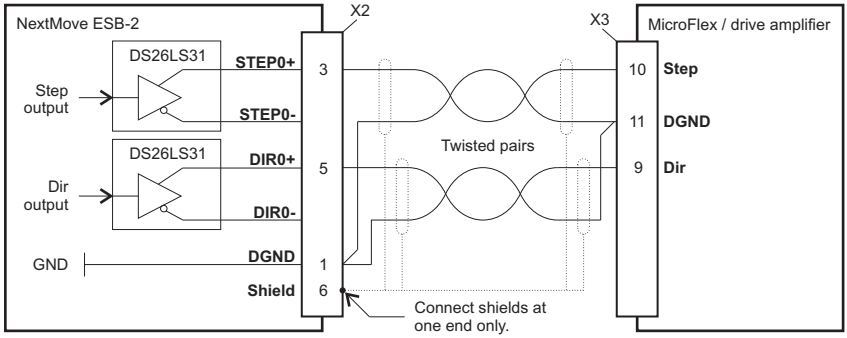


Figure 17: Stepper output - typical connection to Baldor MicroFlex

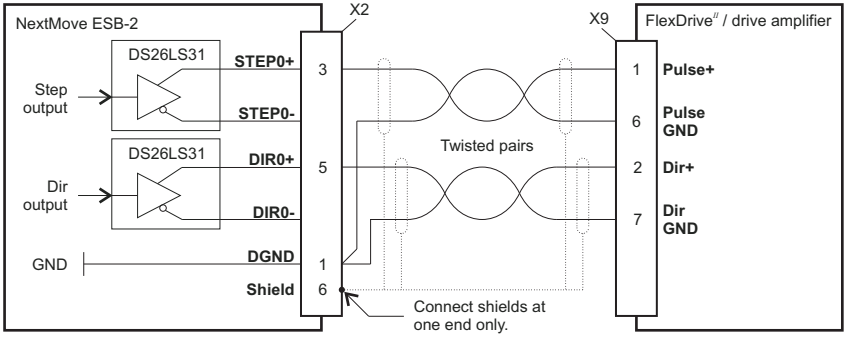


Figure 18: Stepper output - typical connection to Baldor FlexDrive^{II}, Flex+Drive^{II} or MintDrive^{II}

4.4.2 Stepper control outputs - models NSB203... / NSB205...

The stepper control outputs are available on connectors X2 and X3, as shown in section 4.1.1. There are four sets of stepper motor control outputs, operating in the range 0 Hz to 500 kHz. Each of the step (pulse) and direction signals from the NextMove ESB-2 is driven by a ULN2803 open collector Darlington output device. The STEPPERDELAY keyword allows a 0 - 4.25 µs delay to be introduced between state changes of the step and direction outputs. The FREQ keyword can be used to directly control the output frequency, between 60 Hz and 500 kHz - see the Mint help file.

CAUTION

The ULN2803 drivers are static sensitive devices. Take appropriate ESD precautions when handling the NextMove ESB-2. A 5 V, 600 mA supply is provided on connectors X2 and X3 for powering external circuits, as shown in Figure 19. The same 5 V supply is also present on connectors X5, X6, X7, X14 and X15 for powering encoders. Ensure that the total combined current demand of all 5 V outputs does not exceed 1.8 A. In situations where induced noise is affecting a step or direction output, it may be necessary to connect a 5 kΩ or 10 kΩ pull-up resistor between the output and the 5 V supply (pin 4).

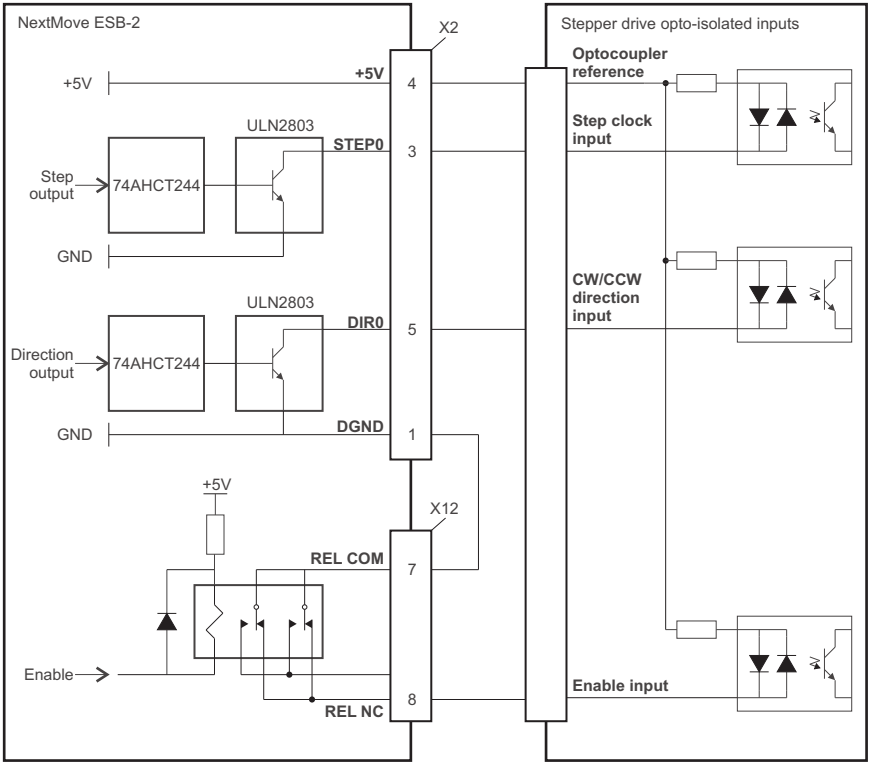
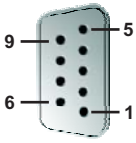


Figure 19: NSB203... / NSB205... only: Connections to a typical stepper drive (e.g. Baldor DSMS series)

4.4.3 Encoder inputs 0-4



Location	X5, X6, X7, X14, X15 Mating connectors: 9-pin male D-type	
Pin	**Name**	**Description**
1	CHA+	Channel A signal
2	CHB+	Channel B signal
3	CHZ+	Index channel signal
4	Shield	Shield connection
5	GND	Digital ground
6	CHA-	Channel A signal complement
7	CHB-	Channel A signal complement
8	CHZ-	Index channel signal complement
9	+5 V out	Power supply to encoder

Five incremental encoders may be connected to NextMove ESB-2, each with complementary A, B and Z channel inputs. Each input channel uses a MAX3095 differential line receiver with pull up resistors and terminators. Encoders must provide RS422 differential signals. The use of individually shielded twisted pair cable is recommended. A 5 V (±5%), 250 mA supply is provided on each connector for powering the encoder. The same 5 V supply is also present on connectors X2 and X3 for powering external circuits (see sections 4.4.1 and 4.4.2). Ensure that the total combined current demand of all 5 V outputs does not exceed 1.85 A.

- Encoder inputs ENC 0 - ENC 3 can be read and controlled with a range of Mint keywords beginning with `ENCODER...` . When using these keywords, the encoder's number is used as the channel parameter. For example, `Print ENCODER(2)` reads the ENC 2 input.
- Encoder input ENC 4 can be read and controlled with a range of Mint keywords beginning with `AUXENCODER...` . When its position has been latched by a fast interrupt (see section 4.3.1.1) it can also be controlled using Mint keywords beginning with `FASTAUX...` . When using the `AUXENCODER...` or `FASTAUX...` keywords, the channel parameter 1 is used (i.e. *auxiliary* encoder channel 1). For example, `Print FASTAUXENCODER(1)` reads the latched value read from ENC 4. Note that auxiliary encoder channel 0 is used to reference the auxiliary encoder input formed by digital inputs DIN17 - DIN19 (see section 4.3.1.4).

Input	Example
ENC 0	`Print ENCODER(0)`
ENC 1	`Print ENCODER(1)`
ENC 2	`Print ENCODER(2)`
ENC 3	`Print ENCODER(3)`

Input	Example
ENC 4	`Print AUXENCODER(1)` `Print FASTAUXENCODER(1)`
DIN17 DIN18 DIN19	`Print AUXENCODER(0)`

Figure 20: Encoder inputs - keyword and channel summary

4.4.3.1 Encoder input frequency

The maximum encoder input frequency is affected by the length of the encoder cables.
The theoretical maximum frequency is 10 million quadrature counts per second. This is equivalent to a maximum frequency for the A and B signals of 2.5 MHz. However, the effect of cable length is shown in Table 1:

A and B signal frequency	Maximum cable length	
	meters	feet
1.3 MHz	2	6.56
500 kHz	10	32.8
250 kHz	20	65.6
100 kHz	50	164.0
50 kHz	100	328.1
20 kHz	300	984.2
10 kHz	700	2296.6
7 kHz	1000	3280.8

Table 1: Effect of cable length on maximum encoder frequency

The maximum recommended cable length is 30.5 m (100 ft).

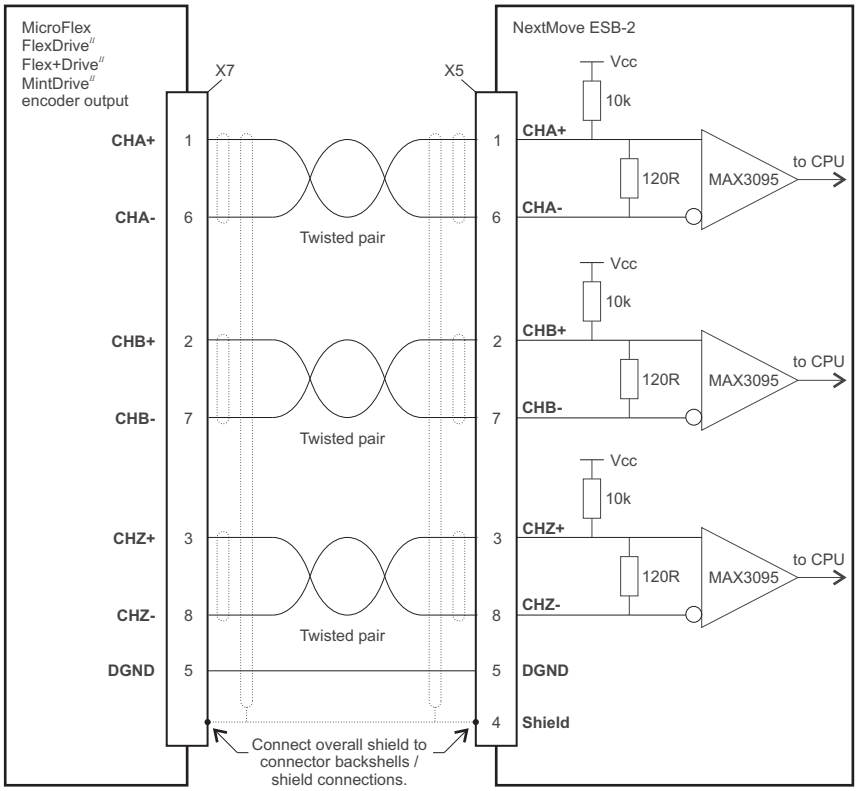


Figure 21: Encoder input 0 - typical connection from a drive amplifier (e.g. Baldor FlexDrive^{II}, Flex+Drive^{II} or MintDrive^{II})

4.4.4 Relay connections

The relay connections are available on connector X12, as shown in section 4.1.1. The relay outputs are isolated from any internal circuits in the NextMove ESB-2. In normal operation, while there is no error, the relay is energized and REL COM is connected to REL NO. In the event of an error or power loss, the relay is de-energized, and REL COM is connected to REL NC. The relay can be controlled by the RELAY keyword, and can be configured as the global error output by setting GLOBALERROROUTPUT to 1000 (_RELAY0). See the Mint help file.

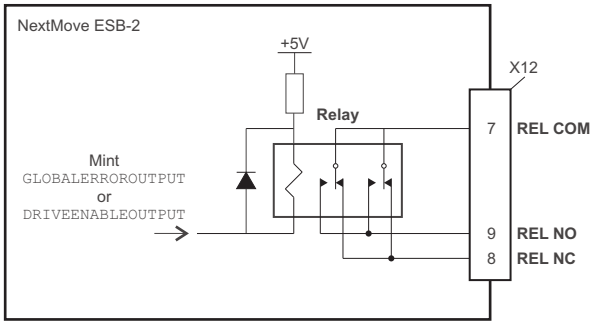
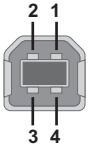


Figure 22: Relay connections

4.4.5 USB port

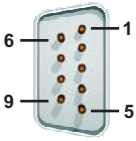


Location	USB Mating connector: USB Type B (downstream) plug	
Pin	**Name**	**Description**
1	VBUS	USB +5 V
2	D-	Data-
3	D+	Data+
4	GND	Ground

The USB connector can be used as an alternative method for connecting the NextMove ESB-2 to a PC running Mint WorkBench. The NextMove ESB-2 is a self-powered, USB 1.1 (12 Mbps) compatible device. If it is connected to a slower USB1.0 host PC or hub, communication speed will be limited to the USB1.0 specification (1.5 Mbps). If it is connected to a faster USB2.0 (480 Mbps) host PC or hub, communication speed will remain at the USB1.1 specification of the NextMove ESB-2.

Ideally, the NextMove ESB-2 should be connected directly to a USB port on the host PC. If it is connected to a hub shared by other USB devices, communication could be affected by the activity of the other devices. A 2 m (6.5 ft) standard USB cable is supplied. The maximum recommended cable length is 5 m (16.4 ft).

4.4.6 Serial port



Location	Serial Mating connector: 9-pin female D-type	
Pin	**RS232 name**	**RS485 / RS422 name**
1	Shield	*(NC)*
2	RXD	RXB (input)
3	TXD	TXB (output)
4	*(NC)*	*(NC)*
5	DGND	0V DGND
6	*(NC)*	*(NC)*
7	RTS	TXA (output)
8	CTS	RXA (input)
9	DGND	*(NC)*

NextMove ESB-2 is available with either an RS232 or RS485 serial port (see section 2.2.1). The port is fully ESD protected to IEC 1000-4-2 (15 kV). When the NextMove ESB-2 is connected to Mint WorkBench, the Tools, Options menu item can be used to configure the serial port. The configuration can also be changed using the Mint keyword `SERIALBAUD` (see the Mint help file for details). It is stored in EEPROM and restored at power up. The port is capable of operation at up to 115.2 Kbaud on RS232.

4.4.7 Using RS232

The NextMove ESB-2 has a full-duplex RS232 serial port with the following preset configuration:

- 57.6 Kbaud
- 1 start bit
- 8 data bits
- 1 stop bit
- No parity
- Hardware handshaking lines RTS and CTS must be connected.

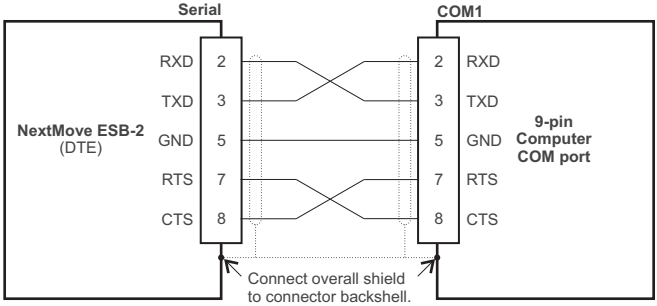


Figure 23: RS232 serial port connections

The RS232 port is configured as a DCE (Data Communications Equipment) unit so it is possible to operate the controller with any DCE or DTE (Data Terminal Equipment). Full duplex transmission with hardware handshaking is supported. Only the TXD, RXD and 0V GND connections are required for communication, but since many devices will check the RTS and CTS lines, these must also be connected. Pins 4 and 6 are linked on the NextMove ESB-2. The maximum recommended cable length is 3 m (10 ft) at 57.6 Kbaud (the factory preset rate). When using lower baud rates, longer cable lengths may be used up to maximum of 15 m (49 ft) at 9600 baud.

4.4.8 Multidrop using RS485 / RS422

Multidrop systems allow one device to act as a 'network master', controlling and interacting with the other (slave) devices on the network. The network master can be a controller such as NextMove ESB-2, a host application such as Mint WorkBench (or other custom application), or a programmable logic controller (PLC). RS422 may be used for multi-drop applications as shown in Figure 24. Four-wire RS485 may be used for single point-to-point applications involving only one Baldor controller. If firmware is updated over RS485/RS422, it can only be downloaded to the controller that was chosen in the Select Controller dialog in Mint WorkBench.

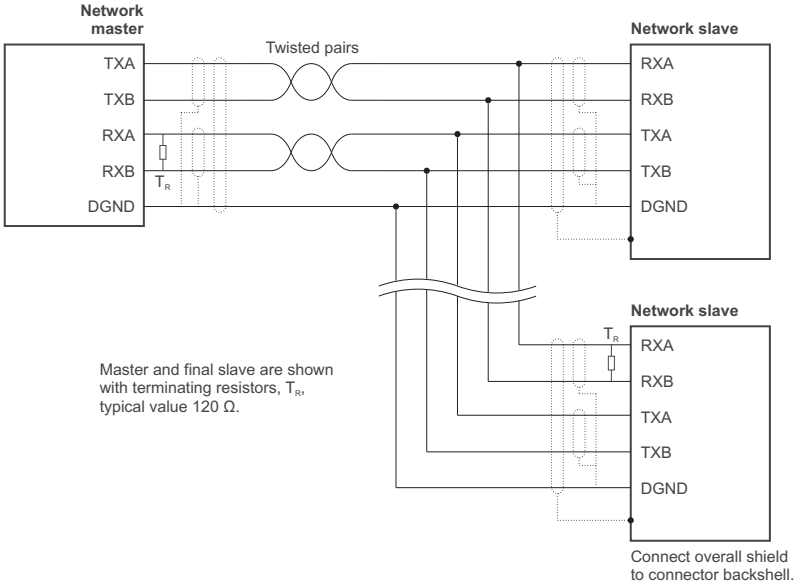


Figure 24: 4-wire RS422 multi-drop connections

Each transmit/receive (TX/RX) network requires a termination resistor at the final RX connection, but intermediate devices must not be fitted with termination resistors. An exception is where repeaters are being used which may correctly contain termination resistors. Termination resistors are used to match the impedance of the load to the impedance of the transmission line (cable) being used. Unmatched impedance causes the transmitted signal to not be fully absorbed by the load. This causes a portion of the signal to be reflected back into the transmission line as noise. If the source impedance, transmission line impedance, and load impedance are all equal, the reflections (noise) are eliminated. Termination resistors increase the load current and sometimes change the bias requirements and increase the complexity of the system.

4.4.9 Connecting serial Baldor HMI Operator Panels

Serial Baldor HMI Operator Panels use a 15-pin male D-type connector (marked PLC PORT), but the NextMove ESB-2 Serial connector uses a 9-pin male D-type connector. The NextMove ESB-2 may be connected as shown in Figure 25:

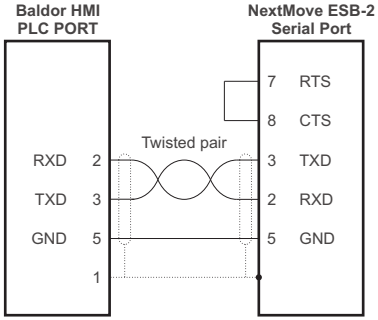


Figure 25: RS232 cable wiring

Alternatively, the Baldor HMI panel may be connected using RS485/422, as shown in Figure 26:

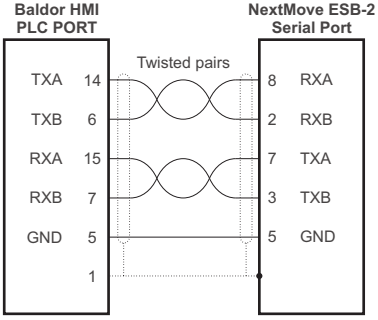


Figure 26: RS485/422 cable wiring

4.5 CAN

The CAN bus is a serial based network originally developed for automotive applications, but now used for a wide range of industrial applications. It offers low-cost serial communications with very high reliability in an industrial environment; the probability of an undetected error is $4.7x10^{-11}$. It is optimized for the transmission of small data packets and therefore offers fast update of I/O devices (peripheral devices) connected to the bus.

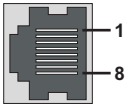
The CAN protocol only defines the physical attributes of the network, i.e. the electrical, mechanical, functional and procedural parameters of the physical connection between devices. The higher level network functionality on NextMove ESB-2 is defined by the CANopen protocol, one of the most used standards for machine control.

In addition to supporting CANopen, Baldor have developed a proprietary protocol called Baldor CAN. Both protocols are supported by NextMove ESB-2, but not at the same time. This is because NextMove ESB-2 only has a single hardware CAN channel. Separate firmware builds are available to support each of the protocols.

To determine which firmware is currently installed, start Mint WorkBench and connect to the NextMove ESB-2 (see section 5.3.2). At the bottom of the Mint WorkBench window, the status bar will show the name of the controller, followed by 'CANopen' or 'Baldor CAN'. If the correct option is not shown, it will be necessary to download alternative firmware by using the Install System File and/or Download Firmware menu items in Mint WorkBench. The firmware can be downloaded from www.baldormotion.com or, in Mint WorkBench, by using the Help, On The Web, Firmware Updates menu option. See the Mint help file for details about downloading firmware.

4.5.1 CAN connector

The CAN connection is made using the RJ45 connector on the NextMove ESB-2.



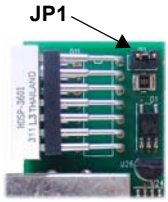
Location	NextMove ESB-2 Mating connector: RJ45 plug	
Pin	**Name**	**Description**
1	CAN+	CAN channel positive
2	CAN-	CAN channel negative
3	-	*(NC)*
4	CAN 0V	Ground/earth reference for CAN signals
5	CAN V+	CAN power V+ (12-24V)
6	-	*(NC)*
7	-	*(NC)*
8	-	*(NC)*
Description: Opto-isolated CAN interface using a RJ45 connector.		

The maximum (default) transmission rate on NextMove ESB-2 is 500 Kbit/s.

4.5.2 CAN wiring

A very low error bit rate over CAN can only be achieved with a suitable wiring scheme, so the following points should be observed:

- The two-wire data bus line may be routed parallel, twisted and/or shielded, depending on EMC requirements. Baldor recommend a twisted pair cable with the shield/screen connected to the connector backshell, in order to reduce RF emissions and provide immunity to conducted interference.
- The bus must be terminated at both ends only (not at intermediate points) with resistors of a nominal value of 120 Ω. This is to reduce reflections of the electrical signals on the bus, which helps a node to interpret the bus voltage levels correctly. If the NextMove ESB-2 is at the end of the network then ensure that jumper JP1, located just behind the status display, is in position. This will connect an internal terminating resistor. To access the jumper it will be necessary to remove the top cover from the NextMove ESB-2. Before removing the top cover be sure to discharge static electricity from your body and clothing by touching a grounded metal surface. Alternatively, wear an earth strap while handling the unit.



- All cables and connectors should have a nominal impedance of 120 Ω. Cables should have a length related resistance of 70 mΩ/m and a nominal line delay of 5 ns/m. A range of suitable CAN cables are available from Baldor, with catalog numbers beginning CBL004-5... .
- The maximum bus length depends on the bit-timing configuration (baud rate). The table opposite shows the approximate maximum bus length (worst-case), assuming 5 ns/m propagation delay and a total effective device internal in-out delay of 210 ns at 1 Mbit/s, 300 ns at 500 - 250 Kbit/s, 450 ns at 125 Kbit/s and 1.5 ms at 50 - 10 Kbit/s.

CAN Baud Rate	Maximum BUS Length
1 Mbit/s	25 m
500 Kbit/s	100 m
250 Kbit/s	250 m
125 Kbit/s	500 m
100 Kbit/s(1)	600 m
50 Kbit/s	1000 m
20 Kbit/s	2500 m(2)
10 Kbit/s	5000 m(2)

(1) CAN baud rate not supported on Baldor CAN.

(2) For bus lengths greater than about 1000 m, bridge or repeater devices may be needed.

- The compromise between bus length and CAN baud rate must be determined for each application. The CAN baud rate can be set using the BUSBAUD keyword. It is essential that all nodes on the network are configured to run at the same baud rate.
- The wiring topology of a CAN network should be as close as possible to a single line/bus structure. However, stub lines are allowed provided they are kept to a minimum (<0.3 m at 1 Mbit/s).
- The 0 V connection of all of the nodes on the network must be tied together through the CAN cabling. This ensures that the CAN signal levels transmitted by NextMove ESB-2 or CAN peripheral devices are within the common mode range of the receiver circuitry of other nodes on the network.

4.5.3 CANopen

The NextMove ESB-2 must have the CANopen firmware loaded to use this protocol.

Baldor have implemented a CANopen protocol in Mint (based on the 'Communication Profile' CiA DS-301) which supports both direct access to device parameters and time-critical process data communication. The NextMove ESB-2 design does not comply with a specific CANopen device profile (DS4xx), although it is able to support and communicate with the following devices:

- Any third party digital and analog I/O device that is compliant with the 'Device Profile for Generic I/O Modules' (CiA DS-401).
- Baldor HMI (Human Machine Interface) operator panels, which are based on the 'Device Profile for Human Machine Interfaces' (DS403).
- Other Baldor controllers with CANopen support for peer-to-peer access using extensions to the CiA specifications (DS301 and DS302).

The functionality and characteristics of all Baldor CANopen devices are defined in individual standardized (ASCII format) Electronic Data Sheets (EDS) which can be found on the Mint Motion Toolkit CD supplied with your product, or downloaded from www.baldormotion.com.

The configuration and management of a CANopen network must be carried out by a single node acting as the network master. This role can be performed by the NextMove ESB-2 when it is configured to be the Network Manager node (node ID 1), or by a third party CANopen master device.

Up to 126 CANopen nodes (node IDs 2 to 127) can be added to the network by a NextMove ESB-2 Manager node using the Mint `NODESCAN` keyword. If successful, the nodes can then be connected to using the Mint `CONNECT` keyword. Any network and node related events can then be monitored using the Mint `BUS1` event.

Note: All CAN related Mint keywords are referenced to either CANopen or Baldor CAN using the 'bus' parameter. Although the NextMove ESB-2 has a single physical CAN bus channel that may be used to carry either protocol, Mint distinguishes between the protocols with the 'bus' parameter. For CANopen the 'bus' parameter must be set to 1.

Please refer to the Mint help file for further details on CANopen, Mint keywords and keyword parameters.

4.5.3.1 CAN opto-isolators and power supply

The NextMove ESB-2 CAN channel is opto-isolated, so a voltage in the range 12-24 V must be applied to pin 5 of the CAN connector. From this supply, an internal voltage regulator provides the 5 V at 100 mA required for the isolated CAN circuit. Connection of the supply can be achieved by modifying an existing cable (see Figure 27). However, it is recommended to use Baldor adaptor part OPT-CNV001 fitted at the HMI panel (Figure 28). This adaptor provides an RJ45 input to allow standard CAT 5e cable to be used between the HMI panel and the NextMove ESB-2. The adaptor also provides flying lead connections for the application of the CAN power supply.

CAN cables supplied by Baldor are 'category 5' and have a maximum current rating of 1 A, so the maximum number of NextMove ESB-2 units that may be used on one network is limited to ten. Due to the propagation delay of the opto-isolators, the 1 Mbit/s baud rate might not be attainable in some applications.

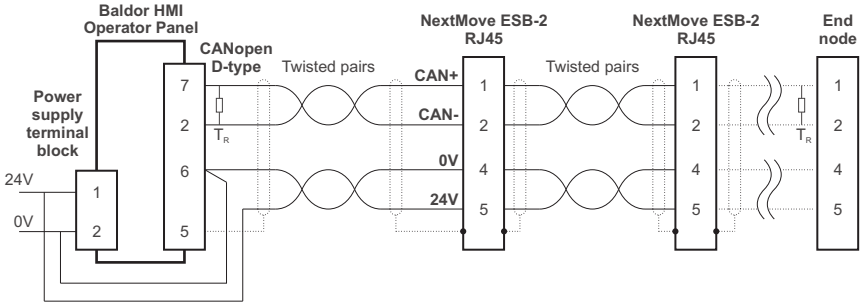


Figure 27: Typical CANopen network: 24 V applied using modified cable

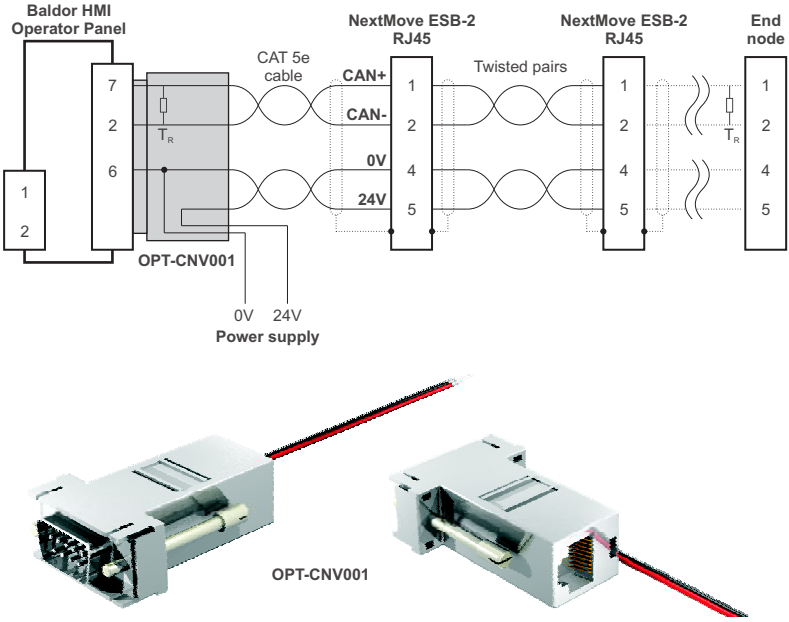


Figure 28: Typical CANopen network: 24 V applied using OPT-CNV001

4.5.4 Baldor CAN

The NextMove ESB-2 must have the Baldor CAN firmware loaded to use this protocol.

Baldor CAN is a proprietary CAN protocol based on CAL. It supports only the following range of Baldor CAN specific I/O nodes and operator panels:

- InputNode 8 (Baldor part ION001-503) - an 8 x digital input CAN node.
- OutputNode 8 (Baldor part ION003-503) - an 8 x digital output CAN node.
- RelayNode 8 (Baldor part ION002-503) - an 8 x relay CAN node.
- IoNode 24/24 (Baldor part ION004-503) - a 24 x digital input and 24 x digital output CAN node.
- KeypadNode (Baldor part KPD002-501, obsolete) - an operator panel CAN node with a 4 x 20 LCD display and 27 key membrane labeled for control of 3 axes (X, Y, Z).
- KeypadNode 4 (Baldor part KPD002-505, obsolete) - an operator panel CAN node with a 4 x 20 LCD display and 41 key membrane labeled for control of 4 axes (1, 2, 3, 4).

A typical Baldor CAN network with a NextMove ESB-2 and a Baldor CAN operator panel is shown in Figure 29.

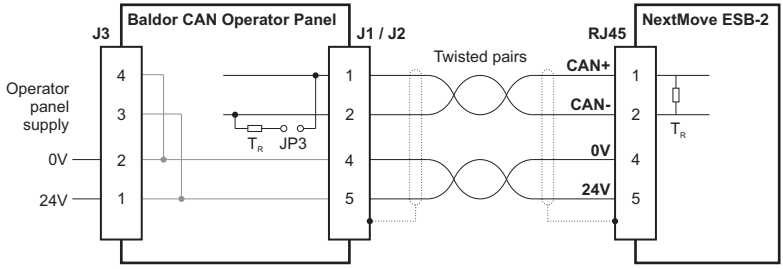


Figure 29: Baldor CAN operator panel connections

The NextMove ESB-2 CAN channel is opto-isolated, so a voltage in the range 12-24 V must be applied to pin 5 of the CAN connector. From this supply, an internal voltage regulator provides the 5 V required for the isolated CAN circuit. The required 12-24 V can be sourced from the Baldor CAN I/O node or operator panel's supply, which is internally connected to the CAN connector as shown in Figure 29.

On Baldor CAN I/O nodes and operator panels, jumpers JP1 and JP2 must be set to position ‘1’ (the lower position) for the network to operate correctly. This configures the node's CAN channel to operate on pins 1 and 2 of the RJ45 connectors. On the Baldor CAN node, jumper JP3 can be used to connect an internal 120 Ω terminating resistor, provided the node is at the end of the network. Jumpers JP4 and JP5 can be used to configure the node ID and baud rate.

Up to 63 Baldor I/O nodes (including no more than 4 operator panels) can be added to the network by the NextMove ESB-2 using the Mint `NODETYPE` keyword. Any network and node related events can then be monitored using the Mint `BUS2` event.

Note: All CAN related Mint keywords are referenced to either CANopen or Baldor CAN using the 'bus' parameter. Although the NextMove ESB-2 has a single physical CAN bus channel that may be used to carry either protocol, Mint distinguishes between the protocols with the 'bus' parameter. For Baldor CAN the 'bus' parameter must be set to 2.

Please refer to the Mint help file for further details on Baldor CAN, Mint keywords and keyword parameters.

4.6 Connection summary - minimum system wiring

As a guide, Figure 30 shows an example of the typical minimum wiring required to allow the NextMove ESB-2 and a single axis drive amplifier to work together. Details of the connector pins are shown in Table 2.

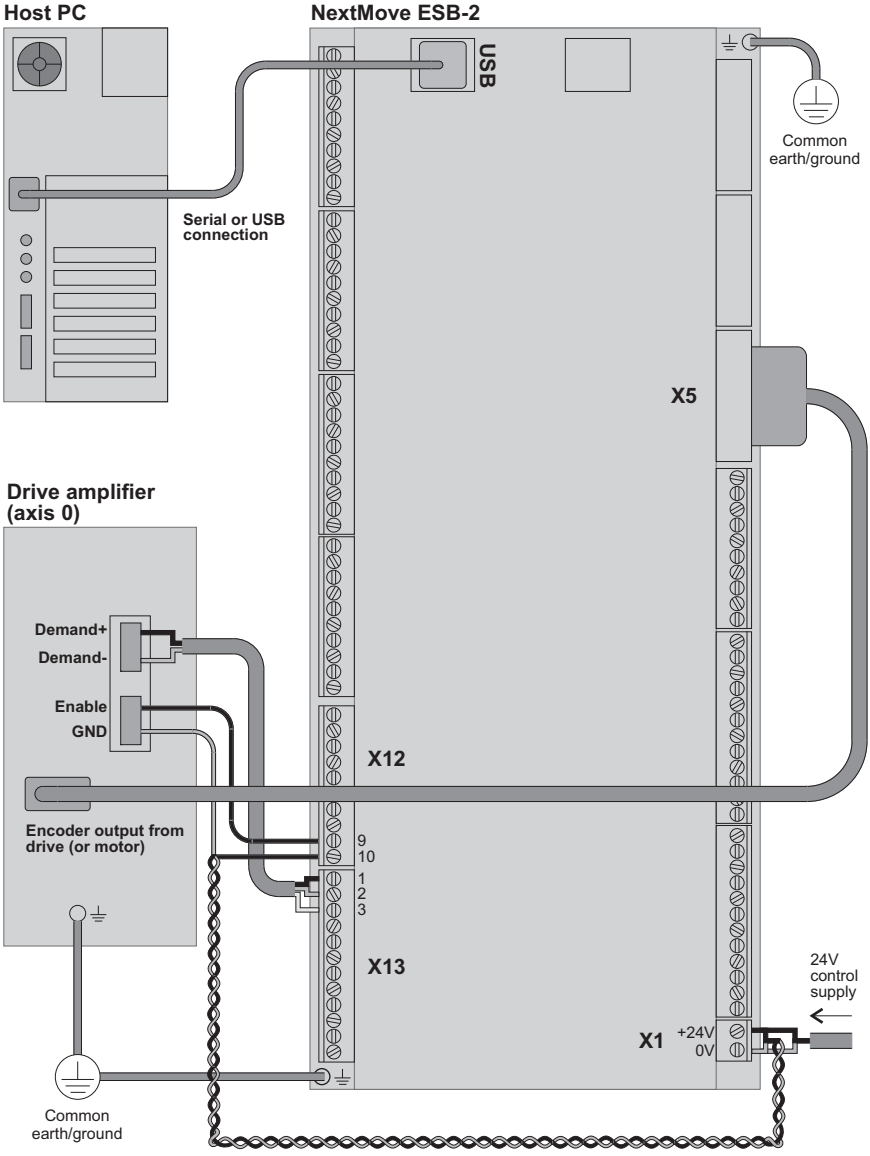


Figure 30: Example minimum system wiring

NextMove ESB-2 connector	Pin	Name of signal	Function	Connection on amplifier (Note: connections may be labeled differently)
X1	1	0V	Control supply ground	
	2	+24 V	Control supply +24 V input	
X5		Encoder0	Encoder0 feedback input	Encoder output
X12	9	REL NO	Normally open relay contact (closed to enable drive)	Enable +24 V
	10	REL COM	Common relay connection	Enable GND
X13	1	Demand0	Demand output 0	Demand+
	2	AGND	Analog GND	Demand-
	3	Shield	Shield connection	*(Do not connect)*

Table 2: Connector details for minimum system wiring shown in Figure 30

5.1 Introduction

Before powering the NextMove ESB-2 you will need to connect it to the PC using a serial or USB cable and install the supplied PC software *Mint WorkBench*. This software includes a number of tools to allow you to configure, tune and program the NextMove ESB-2. If you do not have experience of software installation or Windows applications you may need further assistance for this stage of the installation.

5.1.1 Connecting the NextMove ESB-2 to the PC

The NextMove ESB-2 can be connected to the PC using either RS232 or RS485 (model dependent), or USB (all models).

To use RS232 or RS485, connect an appropriate serial cable between a PC serial port (often labeled as "COM") and the NextMove ESB-2 Serial connector. If you are using an intermediate RS232 to RS485 converter, connect this as specified by the manufacturer. Mint WorkBench can scan all the PC's COM ports, so you can use any port. If you are not using the Baldor serial cable CBL001-501, your cable must be wired in accordance with Figure 23 in section 4.4.7.

To use USB, connect a USB cable between a PC USB port and the NextMove ESB-2 USB connector. Your PC must be running Windows 2000, Windows XP or Windows Vista.

5.1.2 Installing Mint Machine Center and Mint WorkBench

You will need to install Mint Machine Center (MMC) and Mint WorkBench to configure and tune the NextMove ESB-2. Any previous version of Mint WorkBench must be uninstalled before proceeding with this installation:

1. Insert the CD into the drive.
2. After a few seconds the setup wizard should start automatically. If the setup wizard does not appear, select Run... from the Windows Start menu and type

   d:\start

   where **d** represents the drive letter of the CD device.

   Follow the on-screen instructions to install MMC (including Mint WorkBench). The setup wizard will copy the files to appropriate folders within the C:\Program Files folder, and place shortcuts on the Windows Start menu.

5.1.3 Starting the NextMove ESB-2

If you have followed the instructions in the previous sections, you should have now connected the power sources, your choice of inputs and outputs, and a serial or USB cable linking the PC with the NextMove ESB-2.

5.1.4 Preliminary checks

Before you apply power for the first time, it is very important to verify the following:

- Disconnect the load from the motor until instructed to apply a load.
- Inspect all power connections for accuracy, workmanship and tightness.
- Verify that all wiring conforms to applicable codes.
- Verify that the NextMove ESB-2 is properly earthed/grounded.
- Check all signal wiring for accuracy.

5.1.5 Power on checks

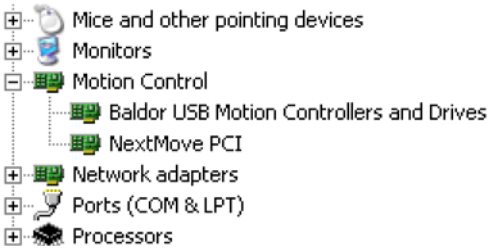
If the status display shows one of the digits 0 - 7 with a flashing decimal point during startup, this indicates that the NextMove ESB-2 has detected a fault - see section 6.

1. Turn on the 24 V control supply.
2. After a brief test sequence (8 followed by -.), the Status display should show the node number, for example 2, the factory default. If the display is not lit then re-check the power supply connections.

5.1.5.1 Installing the USB driver

If you have connected the NextMove ESB-2 to the PC using the USB connection, it will be necessary to install the USB driver. When the NextMove ESB-2 is powered, Windows will automatically detect the controller and request the driver.

1. Follow the on-screen instructions to select and install the driver. The driver files are available on the supplied Mint Motion Toolkit CD. If you are using a copy of the driver located on the hard disk, a floppy disk or another CD, the driver files must all be in the same folder.
2. During installation, Windows may report that the driver is 'unsigned'. This is normal for the NextMove ESB-2 driver, so click the Continue Anyway button to continue with the installation. When installation is complete, a new Motion Control category will be listed in Windows Device Manager.



The NextMove ESB-2 is now ready to be configured using Mint WorkBench.

Note: If the NextMove ESB-2 is later connected to a different USB port on the host computer, Windows may report that it has found new hardware. Either install the driver files again for the new USB port, or connect the NextMove ESB-2 to the original USB port where it will be recognized in the usual way.

5.2 Mint Machine Center

The Mint Machine Center (MMC) is used to view the network of connected controllers in a system. Individual controllers and drives are configured using Mint WorkBench.

Note: If you have only a single NextMove ESB-2 connected to your PC, then MMC is probably not required. Use Mint WorkBench (see section 5.4) to configure the NextMove ESB-2.

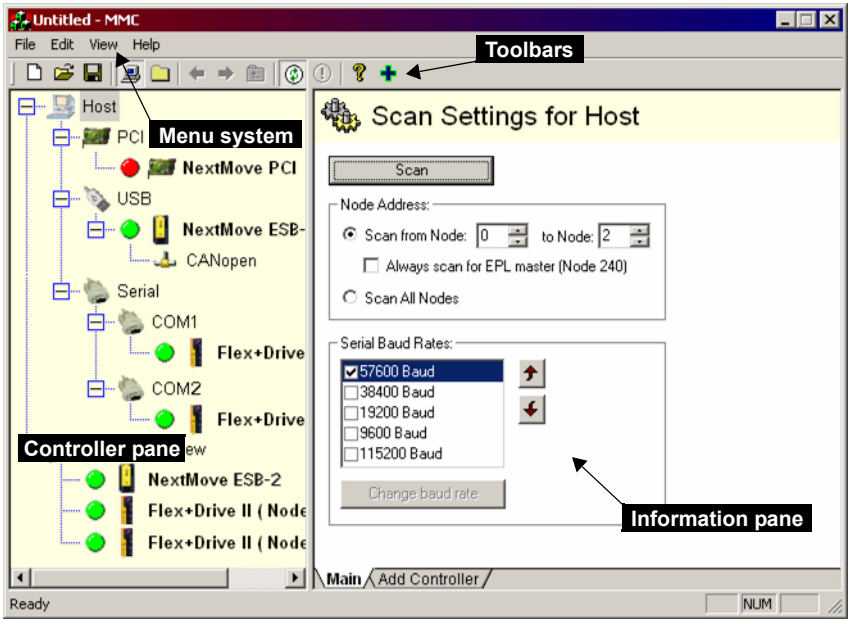


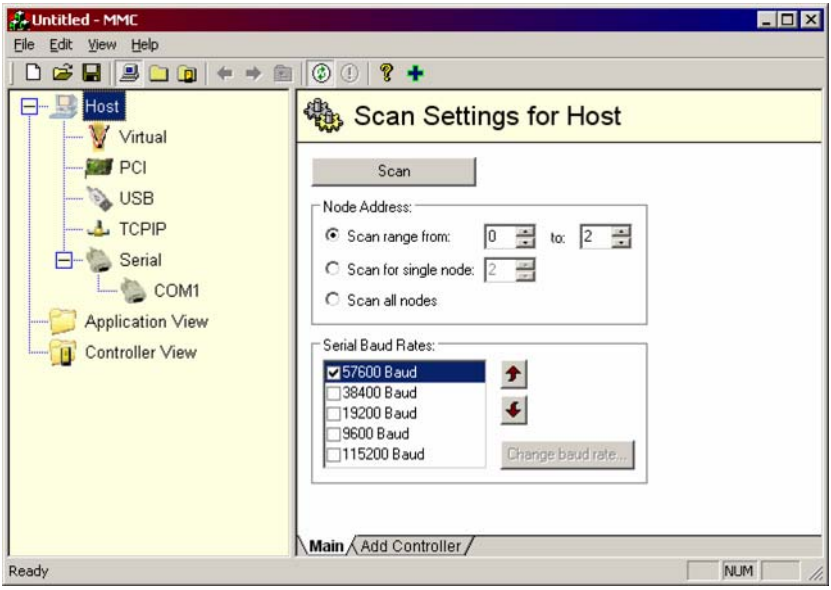
Figure 31: The Mint Machine Center software

The Mint Machine Center (MMC) provides an overview of the controller network currently accessible by the PC. The MMC contains a controller pane on the left, and an information pane on the right. In the controller pane select the Host item, then in the information pane click **Scan**. This causes MMC to scan for all connected controllers. Clicking once on a controller's name causes various options to be displayed in the information pane. Double-clicking on a controller's name launches an instance of Mint WorkBench that is automatically connected to the controller.

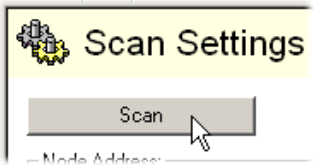
Application View allows the layout and organization of controllers in your machine to be modelled and described on screen. Controllers can be dragged onto the Application View icon, and renamed to give a more meaningful description, for example "Conveyor 1, Packaging Controller". Drives that are controlled by another product, such as NextMove ESB-2, can be dragged onto the NextMove ESB-2 icon itself, creating a visible representation of the machine. A text description for the system and associated files can be added, and the resulting layout saved as an ‘MMC Workspace’. When you next need to administer the system, simply loading the workspace automatically connects to all the required controllers. See the Mint help file for full details of MMC.

5.2.1 Starting MMC

1. On the Windows Start menu, select Programs, Mint Machine Center, Mint Machine Center.

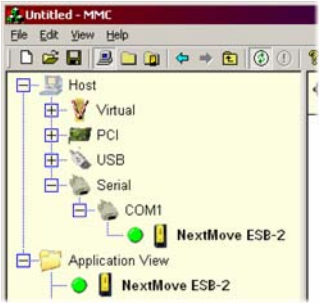


2. In the controller pane, ensure that Host is selected. In the information pane, click **Scan**.



3. When the search is complete, click once on 'NextMove ESB-2' in the controller pane to select it, then double click to open an instance of Mint WorkBench. The NextMove ESB-2 will be already connected to the instance of Mint WorkBench, ready to configure.

   Go straight to section 5.4 to continue the configuration in Mint WorkBench.



5.3 Mint WorkBench

Mint WorkBench is a fully featured application for programming and controlling the NextMove ESB-2. The main WorkBench window contains a menu system, the Toolbox and other toolbars. Many functions can be accessed from the menu or by clicking a button - use whichever you prefer. Most buttons include a 'tool-tip'; hold the mouse pointer over the button (don't click) and its description will appear.

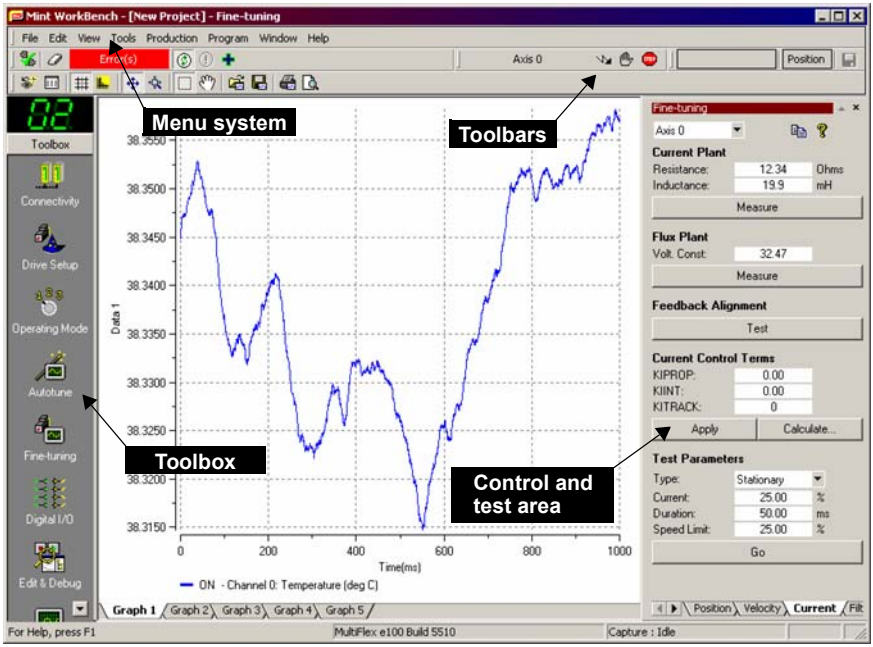


Figure 32: The Mint WorkBench software

5.3.1 Help file

Mint WorkBench includes a comprehensive help file that contains information about every Mint keyword, how to use Mint WorkBench and background information on motion control topics. The help file can be displayed at any time by pressing F1. On the left of the help window, the Contents tab shows the tree structure of the help file; each book contains a number of topics. The Index tab provides an alphabetic list of all topics in the file, and allows you to search for them by name. The Search tab allows you to search for words or phrases appearing anywhere in the help file. Many words and phrases are underlined and highlighted with a color (normally blue) to show that they are links. Just click on the link to go to an associated keyword. Most keyword topics begin with a list of relevant See Also links.

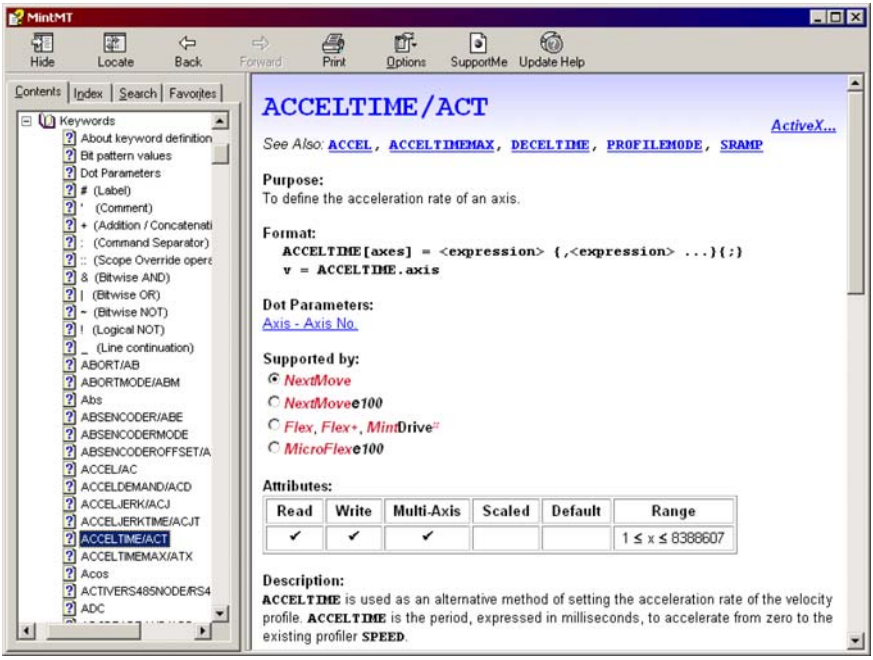


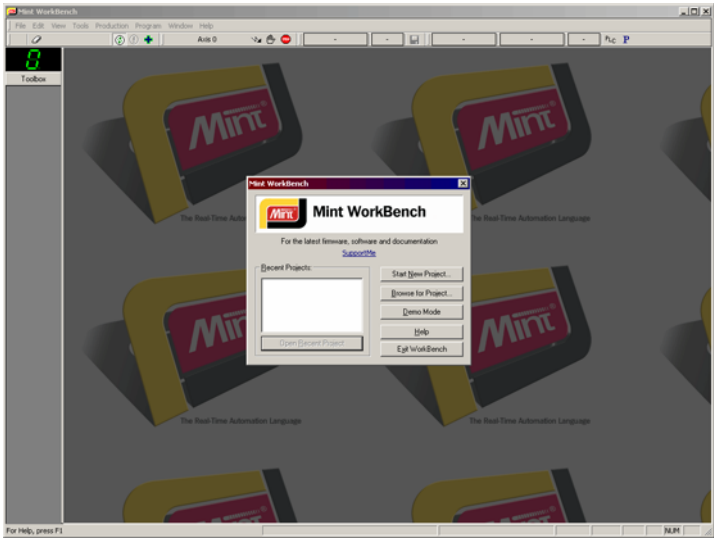
Figure 33: The Mint WorkBench help file

For help on using Mint WorkBench, click the **Contents** tab, then click the small plus sign beside the **Mint WorkBench & Mint Machine Center** book icon. Double click a topic name to display it.

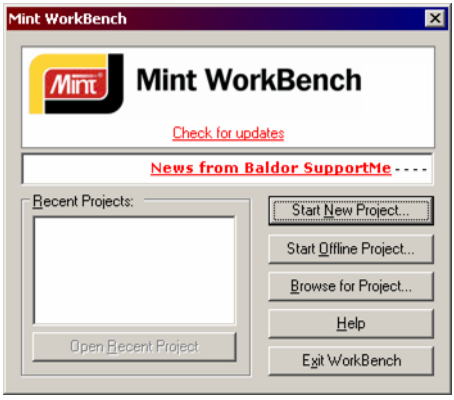
5.3.2 Starting Mint WorkBench

Note: If you have already used MMC to install firmware and start an instance of Mint WorkBench, go straight to section 5.4 to continue configuration.

1. On the Windows Start menu, select Programs, Mint Machine Center, Mint WorkBench.



2. In the opening dialog box, click **Start New Project...** ..

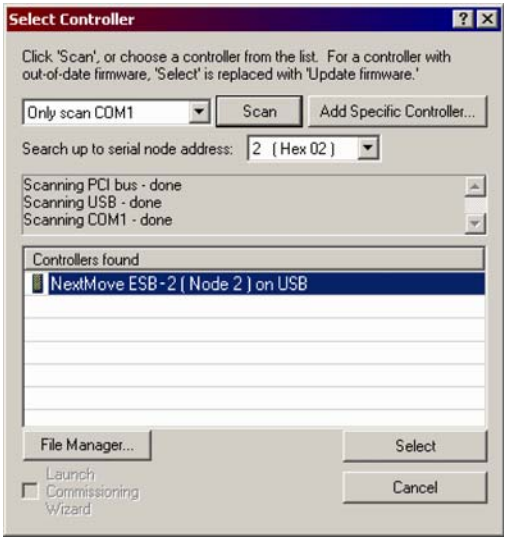


3. In the Select Controller dialog, go to the drop down box near the top and select the PC serial port to which the NextMove ESB-2 is connected.

   (If you are unsure which PC serial port is connected to the NextMove ESB-2, select **Scan all serial ports**. During the detection process, a dialog box may be displayed to tell you that Mint WorkBench has detected new firmware. Click **OK** to continue.)

   Click **Scan** to search for the NextMove ESB-2.

   When the search is complete, click on NextMove ESB-2 in the list to highlight it, and click **Select**.


Select Controller
Click 'Scan', or choose a controller from the list. For a controller with out-of-date firmware, 'Select' is replaced with 'Update firmware.'
Only scan COM1
Scan
Add Specific Controller...
Search up to serial node address:
2 (Hex 02)
Scanning PCI bus - done
Scanning USB - done
Scanning COM1 - done
Controllers found
NextMove ESB-2 (Node 2) on USB
File Manager...
Select
Launch Commissioning Wizard
Cancel

   Note: If the NextMove ESB-2 is not listed, check the USB or serial lead between the NextMove ESB-2 and the PC. Check that the NextMove ESB-2 is powered correctly. Click **Scan** to re-scan the ports.

When detection is complete, Fine-tuning mode will be displayed.

5.4 Configuring an axis

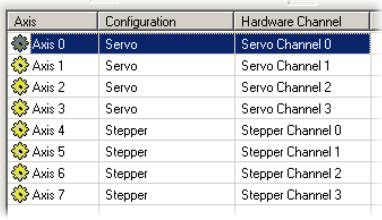
The NextMove ESB-2 is capable of controlling 4 servo and 4 stepper axes. This section describes how to configure both types of axis.

5.4.1 Selecting the axis type

An axis can be configured as either a servo axis or a stepper axis. The factory preset configuration sets all axes as unassigned (off), so it is necessary to configure an axis as either stepper or servo before it can be used. The number of servo and stepper hardware channels defines how many axes of each type may be configured. In the following example, the Mint WorkBench Axis Config Wizard will be used to assign axes:

1. In the Toolbox, click the Axis Config icon.

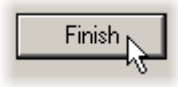
2. For each required axis, click in the Configuration column and select Servo or Stepper from the drop down box.



Axis	Configuration	Hardware Channel
Axis 0	Servo	Servo Channel 0
Axis 1	Servo	Servo Channel 1
Axis 2	Servo	Servo Channel 2
Axis 3	Servo	Servo Channel 3
Axis 4	Stepper	Stepper Channel 0
Axis 5	Stepper	Stepper Channel 1
Axis 6	Stepper	Stepper Channel 2
Axis 7	Stepper	Stepper Channel 3

   The Axis Config Wizard automatically assigns a Hardware Channel to the axis. For example, Servo Channel 0 indicates the servo axis will use the controller's Demand0 output; Stepper Channel 1 indicates the stepper axis will use the controller's STEP1 and DIR1 outputs. Optionally, the default hardware channel assignment can be altered by clicking in the Hardware Channel column and choosing an alternative channel. This means the axis will no longer use the correspondingly numbered physical outputs (Demand*x* or STEP*x* & DIR*x*), so extra care must be taken when connecting the NextMove ESB-2 to drive amplifiers.

3. Click **Finish** to complete the Axis Config Wizard. The axis configuration will be downloaded to the NextMove ESB-2.



Note: If a "Hardware channel required is in use" or "Hardware not available" error message is displayed, the configuration is not downloaded. It is likely that the number of selected servo or stepper axes exceeds the number of physical axes of that type available on the NextMove ESB-2. An error is also caused if the same hardware channel has been selected for more than one servo axis, or for more than one stepper axis.

It is recommended that unused axes are always set to OFF, as this provides more processing time for the axes that are in use. Setting an axis to Virtual means that it can be used to simulate motion within the controller, but uses no physical outputs (hardware channel).

See the Mint help file for details of the `CONFIG` and `AXISCHANNEL` keywords.

5.4.2 Selecting a scale

Mint defines all positional and speed related motion keywords in terms of encoder quadrature counts (for servo motors). The number of quadrature counts is divided by the SCALEFACTOR allowing you to use units more suitable for your application. The unit defined by setting a value for scale is called the user unit (uu).

Consider a motor with a 1000 line encoder. This provides 4000 quadrature counts for each revolution. If SCALEFACTOR is not set, a Mint command that involves distance, speed, or acceleration may need to use a large number to specify a significant move. For example MOVER(0)=16000 (Move Relative) would rotate the motor by 16000 quadrature counts - only four revolutions. By setting a SCALEFACTOR factor of 4000, the user unit becomes revolutions. The more understandable command MOVER(0)=4 could now be used to move the motor four revolutions.

In applications involving linear motion a suitable value for SCALEFACTOR would allow commands to express values in linear distance, for example inches, feet or millimeters.

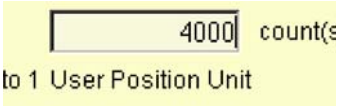
1. In the Toolbox, click the Parameters icon.

2. Click the Scale tab.

3. Click in the Axis drop down box to select the axis.

   Each axis can have a different scale if required.

4. Click in the SCALEFACTOR box and type a value.



5. Click **Apply**.

   This immediately sets the scaling factor for the selected axis. It will remain in the NextMove ESB-2 until another scale is defined, or power is removed.

5.4.3 Setting the drive enable output

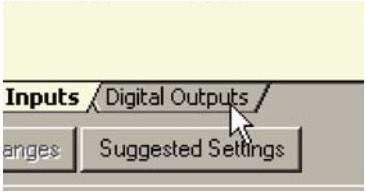
The drive enable output allows NextMove ESB-2 to disable the drive in the event of an error. Each axis can be configured with its own drive enable output, or can share an output with other axes. If an output is shared, an error on any of the axes sharing the output will cause all of them to be disabled.

The drive enable output can either be a digital output or the relay.

1. In the Toolbox, click the Digital I/O icon.

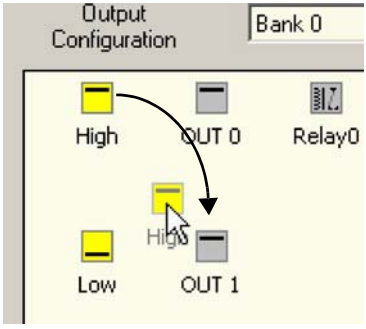
2. At the bottom of the Digital I/O screen, click the **Digital Outputs** tab.

   The left of the screen shows two yellow icons, High and Low. These describe how the output should behave when activated (to enable the axis).

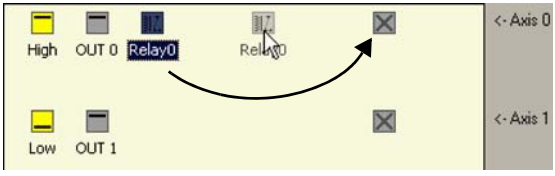


3. If you are going to use the relay, ignore this step and go straight to step 4.

   If you are going to use a digital output, drag the appropriate yellow icon to the grey OUT icon that will be used as the drive enable output. Its color will change to bright blue.

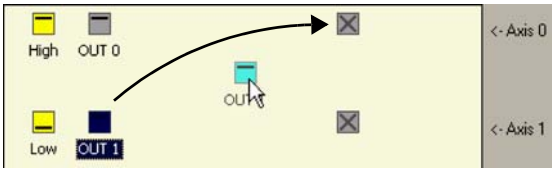


4. If you are going to use the relay, drag the Relay0 icon to the grey Drive Enable OP icon on the right of the screen.



   To configure multiple axes to use the error output, repeat this step for the other axes.

If you are going to use a digital output, drag the bright blue OUT icon to the grey Drive Enable OP axis icon on the right of the screen.



To configure multiple axes with the same drive enable output, repeat this step for the other axes.

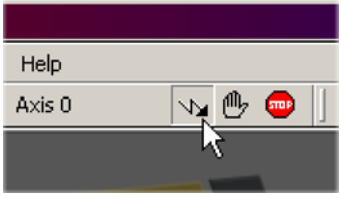
5. Click **Apply** at the bottom of the screen. This sends the output configuration to the NextMove ESB-2.

   See section 5.11 for details about saving configuration parameters.

5.4.4 Testing the drive enable output

1. On the main Mint WorkBench toolbar, click the Axis 0-7 button. In the Select Default Axes dialog, select the axes to be controled. Click **OK** to close the dialog.

2. On the main Mint WorkBench toolbar, click the Drive enable button. Click the button again. Each time you click the button, the drive enable output(s) for the selected axes are toggled. When the button is in the pressed (down) position the drive amplifier should be enabled. When the button is in the raised (up) position the drive amplifier should be disabled.



   If this is not working, or the action of the button is reversed, check the electrical connections between the NextMove ESB-2 and drive amplifier. If you are using the relay, check that you are using the correct normally open (REL NO) or normally closed (REL NC) connections.

   If you are using a digital output, check that it is using the correct high or low triggering method expected by the drive amplifier.

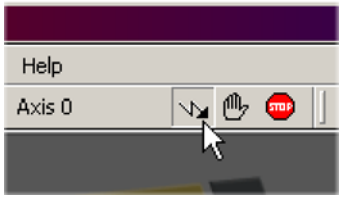
5.5 Stepper axis - testing

This section describes the method for testing a stepper axis. The stepper control is an open loop system so no tuning is necessary.

5.5.1 Testing the output

This section tests the operation and direction of the output. It is recommended that the system is initially tested with the motor shaft disconnected from other machinery.

1. Check that the Drive enable button is pressed (down).



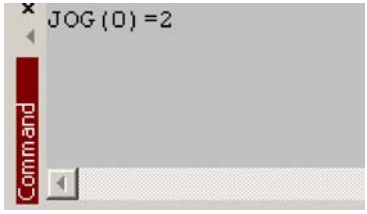
2. In the Toolbox, click the Edit & Debug icon.

3. Click in the Command window.

4. Type:

   `JOG(0)=2`

   where 0 is the axis (stepper output) to be tested and 2 is the speed.



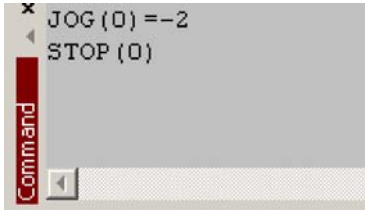
   The `JOG` command specifies the speed in user units per second, so the speed is affected by `SCALEFACTOR` (section 5.4.2). If you have not selected a scale, the command `JOG(0)=2` will cause rotation at only 2 half steps per second, so it may be necessary to increase this figure significantly, to 200 for example. If you have selected a scale that provides user units of revolutions (as described in section 5.4.2) `JOG(0)=2` will cause rotation at 2 revolutions per second. If there appears to be no step or direction output, check the electrical connections to the assigned STEP*x* and DIR*x* outputs.

5. To repeat the tests for reverse moves, type:

   `JOG(0)=-2`

6. To remove the demand and stop the test, type:

   `STOP(0)`



5.6 Servo axis - testing and tuning

This section describes the method for testing and tuning a servo axis. The drive amplifier must already have been tuned for basic current or velocity control of the motor.

5.6.1 Testing the demand output

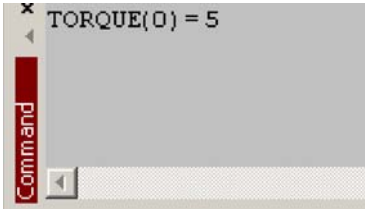
This section tests the operation and direction of the demand output for axis 0. The example assumes that axis 0 has already been configured as a servo axis, using the default hardware channel 0 (see section 5.4.1). It is recommended that the motor is disconnected from the load for this test.

1. Check that the Drive enable button is pressed (down).

2. In the Toolbox, click the Edit & Debug icon.

3. Click in the Command window.

4. Type:




```
TORQUE(0)=5
```

where 0 is the axis to be tested. In this example, this should cause a demand of +5% of maximum output (0.5 V) to be produced at the DEMAND0 output (connector X13, pin 1). In Mint WorkBench, look at the Spy window located on the right of the screen. In the Axis selection box at the top, select Axis 0.

The Spy window's Command display should show 5 percent (approximately). If there seems to be no demand output, check the electrical connections to X13.

The Spy window's Velocity display should show a positive value. If the value is negative check that the DEMAND0 output, and the Encoder0 A and B channels, have been wired correctly. If necessary, the `ENCODERMODE` keyword can be used to swap the encoder A and B channels, thus reversing the encoder count - see the Mint help file.

See section 4.2.2 for details of the demand outputs.

5. To repeat the tests for negative (reverse) demands, type:

   ```
   TORQUE(0)=-5
   ```

6. This should cause a demand of -5% of maximum output (-0.5 V) to be produced at the DEMAND0 output. Correspondingly, the Spy window's Velocity display should show a negative value.

7. To remove the demand and stop the test, type:

   ```
   STOP(0)
   ```

   This should cause the demand produced at the DEMAND0 output to become 0 V.

If it is necessary for the motor to turn in the opposite direction for a positive demand, then the DACMODE and ENCODERMODE keywords should be used. The DACMODE keyword is used to invert the demand output voltage. The ENCODERMODE keyword must then also be used to reverse the incoming feedback signal, to correspond with the inverted demand output. Note that if ENCODERMODE had already been used to compensate for a reversed encoder count (as described in step 4. above), it will be necessary to change it back to its original setting to correspond with the inverted demand output set using DACMODE. See the Mint help file for details of each keyword.

5.6.2 An introduction to closed loop control

This section describes the basic principles of closed loop control. If you are familiar with closed loop control go straight to section 5.7.1.

When there is a requirement to move an axis, the NextMove ESB-2 control software translates this into a demand output voltage. This is used to control the drive amplifier which powers the motor. An encoder or resolver on the motor is used to measure the motor's position. At specified intervals* the NextMove ESB-2 compares the demanded and measured positions. It then calculates the demand needed to minimize the difference between them, known as the **following error**.

This system of constant measurement and correction is known as closed loop control.
[*For the analogy, imagine you are in your car waiting at an intersection. You are going to go straight on when the lights change, just like the car standing next to you which is called* Demand*. You're not going to race* Demand *though - your job as the controller (NextMove ESB-2) is to stay exactly level with* Demand*, looking out of the window to measure your position*].

The main term that the NextMove ESB-2 uses to correct the error is called **Proportional gain** (**KPROP**). A very simple proportional controller would simply multiply the amount of error by the Proportional gain and apply the result to the motor [*the further* Demand *gets ahead or behind you, the more you press or release the gas pedal*].

If the Proportional gain is set too high overshoot will occur, resulting in the motor vibrating back and forth around the desired position before it settles [*you press the gas pedal so hard you go right past* Demand*. To try and stay level you ease off the gas, but end up falling behind a little. You keep repeating this and after a few tries you end up level with* Demand*, traveling at a steady speed. This is what you wanted to do but it has taken you a long time*].
If the Proportional gain is increased still further, the system becomes unstable [*you keep pressing and then letting off the gas pedal so hard you never travel at a steady speed*].

To reduce the onset of instability, a term called **Velocity Feedback gain** (**KVEL**) is used. This resists rapid movement of the motor and allows the Proportional gain to be set higher before vibration starts. Another term called **Derivative gain** (**KDERIV**) can also be used to give a similar effect.

With Proportional gain and Velocity Feedback gain (or Derivative gain) it is possible for a motor to come to a stop with a small following error [Demand *stopped so you stopped too, but not quite level*]. The NextMove ESB-2 tries to correct the error, but because the error is so small the amount of torque demanded might not be enough to overcome friction.

This problem is overcome by using a term called **Integral gain** (**KINT**). This sums the error over time, so that the motor torque is gradually increased until the positional error is reduced to zero [*like a person gradually pushing harder and harder on your car until they've pushed it level with* Demand].

However, if there is large load on the motor (it is supporting a heavy suspended weight for example), it is possible for the output to increase to 100% demand. This effect can be limited using the `KINTLIMIT` keyword which limits the effect of KINT to a given percentage of the demand output. Another keyword called `KINTMODE` can even turn off integral action when it's not needed.

* The sampling interval can be changed using the `LOOPTIME` keyword to either 1 ms or 2 ms.

The remaining gain terms are **Velocity Feed forward** (**KVELFF**) and **Acceleration Feed forward** (**KACCEL**) described below.

In summary, the following rules can be used as a guide:

- KPROP: Increasing KPROP will speed up the response and reduce the effect of disturbances and load variations. The side effect of increasing KPROP is that it also increases the overshoot, and if set too high it will cause the system to become unstable. The aim is to set the Proportional gain as high as possible without getting overshoot, instability or hunting on an encoder edge when stationary (the motor will buzz).
- KVEL: This gain has a damping effect on the whole response, and can be increased to reduce any overshoot. If KVEL becomes too large it will amplify any noise on the velocity measurement and introduce oscillations.
- KINT: This gain has a de-stabilizing effect, but a small amount can be used to reduce any steady state errors. By default, KINTMODE is always on (mode 1).
- KINTLIMIT: The integration limit determines the maximum value of the effect of integral action. This is specified as a percentage of the full scale demand.
- KDERIV: This gain has a damping effect dependent on the rate of change of error, and so is particularly useful for removing overshoot.
- KVELFF: This is a feed forward term and as such has a different effect on the servo system than the previous gains. KVELFF is outside the closed loop and therefore does not have an effect on system stability. This gain allows a faster response to demand speed changes with lower following errors, for example you would increase KVELFF to reduce the following error during the slew section of a trapezoidal move. The trapezoidal test move can be used to fine-tune this gain. This term is especially useful with velocity controlled servos
- KACCEL: This term is designed to reduce velocity overshoots on high acceleration moves.

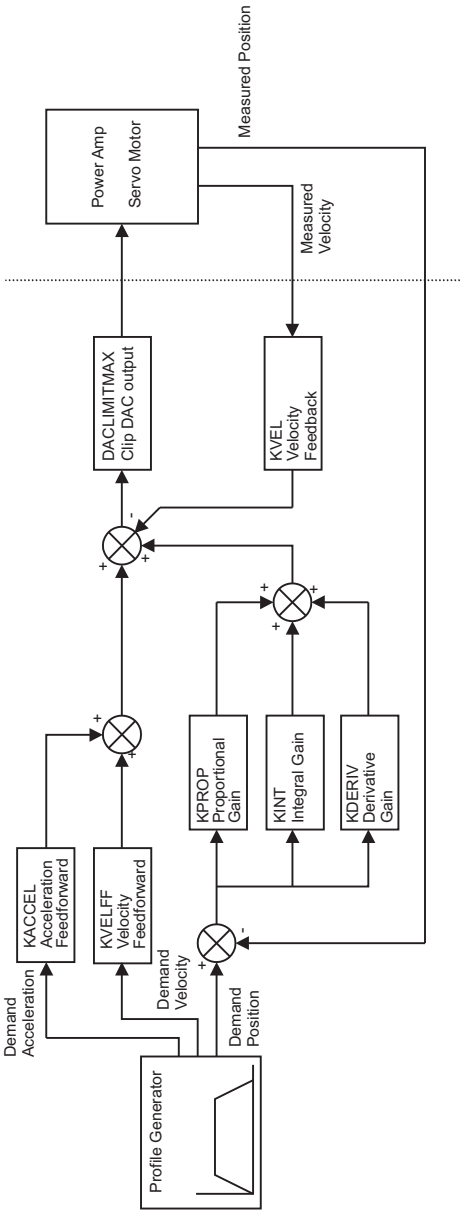


Figure 34: The NextMove ESB-2 servo loop

5.7 Servo axis - tuning for current control

5.7.1 Selecting servo loop gains

All servo loop parameters default to zero, meaning that the demand output will be zero at power up. Most drive amplifiers can be set to current (torque) control mode or velocity control mode; check that the drive amplifier will operate in the correct mode. The procedure for setting system gains differs slightly for each. To tune an axis for velocity control, go straight to section 5.8. It is recommended that the system is initially tested and tuned with the motor shaft disconnected from other machinery. Confirm that the encoder feedback signals from the motor or drive amplifier have been connected, and that a positive demand causes a positive feedback signal.

Note: The method explained in this section should allow you to gain good control of the motor, but will not necessarily provide the optimum response without further fine-tuning. Unavoidably, this requires a good understanding of the effect of the gain terms.

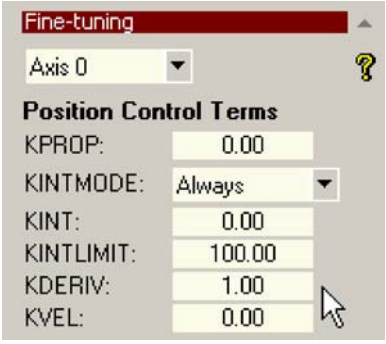
1. In the Toolbox, click the Fine-tuning icon.

   The Fine-tuning window is displayed at the right of the screen. The main area of the Mint WorkBench window displays the Capture window. When tuning tests are performed, this will display a graph representing the response.

2. In the Fine-tuning window, click in the Axis selection box at the top and select Axis 0 (assuming axis 0 has already been configured as a servo axis - see section 5.4.1).

   Click in the KDERIV box and enter a starting value of 1.

   Click **Apply** and then turn the motor shaft by hand. Repeat this process, slowly increasing the value of KDERIV until you begin to feel some resistance in the motor shaft. The exact value of KDERIV is not critical at this stage.



3. Click in the KPROP box and enter a value that is approximately one quarter of the value of KDERIV. If the motor begins to vibrate, decrease the value of KPROP or increase the value of KDERIV until the vibration stops. Small changes may be all that is necessary.

4. In the Move Type drop down box, check that the move type is set to Step.

5. Click in the Distance box and enter a distance for the step move. It is recommended to set a value that will cause the motor to turn a short distance, for example one revolution.

Note: The distance depends on the scale set in section 5.4.2. If you set a scale so that units could be expressed in revolutions (or other unit of your choice), then those are the units that will be used here. If you did not set a scale, the amount you enter will be in encoder counts.

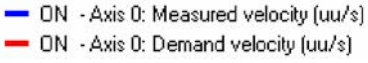
6. Click in the Duration box and enter a duration for the move, in seconds. This should be a short duration, for example 0.15 seconds.

7. Click **Go**.

The NextMove ESB-2 will perform the move and the motor will turn. As the soon as the move is completed, Mint WorkBench will upload captured data from the NextMove ESB-2. The data will then be displayed in the Capture window as a graph.

Note: The graphs that you see will not look exactly the same as the graphs shown here! Remember that each motor has a different response.

8. Using the check boxes below the graph, select the traces you require, for example Demand position and Measured position.



5.7.2 Underdamped response

If the graph shows that the response is underdamped (it overshoots the demand, as shown in Figure 35) then the value for KDERIV should be increased to add extra damping to the move. If the overshoot is excessive or oscillation has occurred, it may be necessary to reduce the value of KPROP.

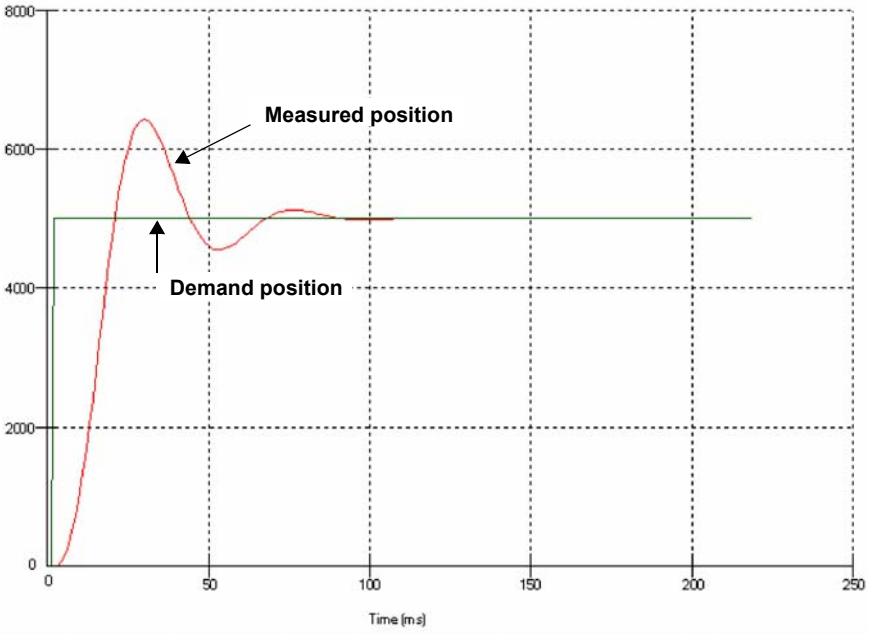
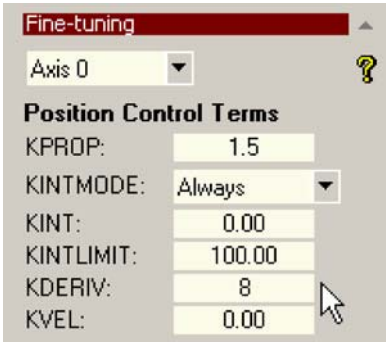


Figure 35: Underdamped response

9. Click in the KDERIV and/or KPROP boxes and make the required changes. The ideal response is shown in section 5.7.4.



5.7.3 Overdamped response

If the graph shows that the response is overdamped (it reaches the demand too slowly, as shown in Figure 36) then the value for KDERIV should be decreased to reduce the damping of the move. If the overdamping is excessive, it may be necessary to increase the value of KPROP.

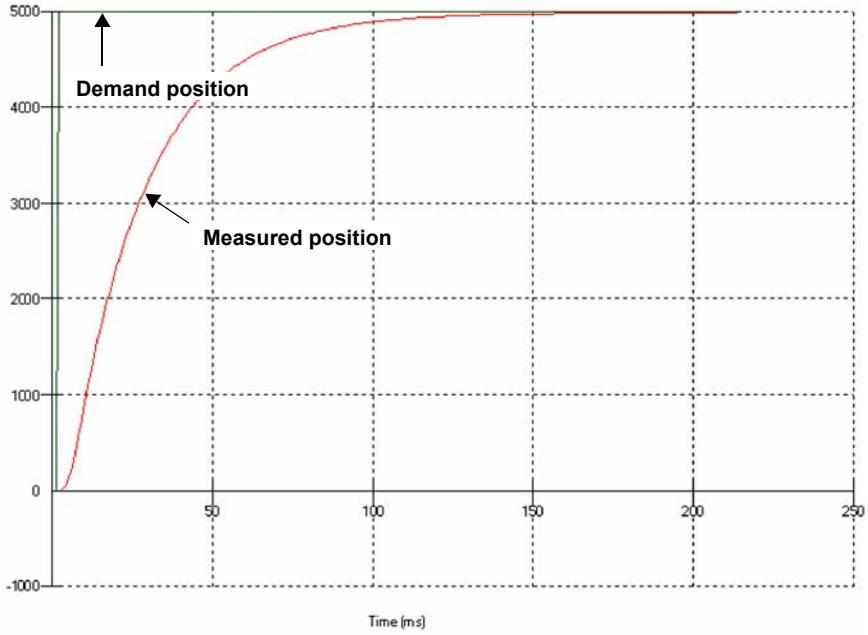
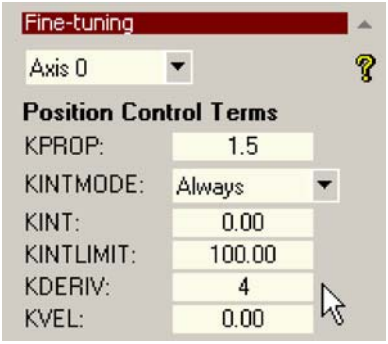


Figure 36: Overdamped response

10. Click in the KDERIV and/or KPROP boxes and make the required changes. The ideal response is shown in section 5.7.4.



5.7.4 Critically damped response

If the graph shows that the response reaches the demand quickly and only overshoots the demand by a small amount, this can be considered an ideal response for most systems. See Figure 37.

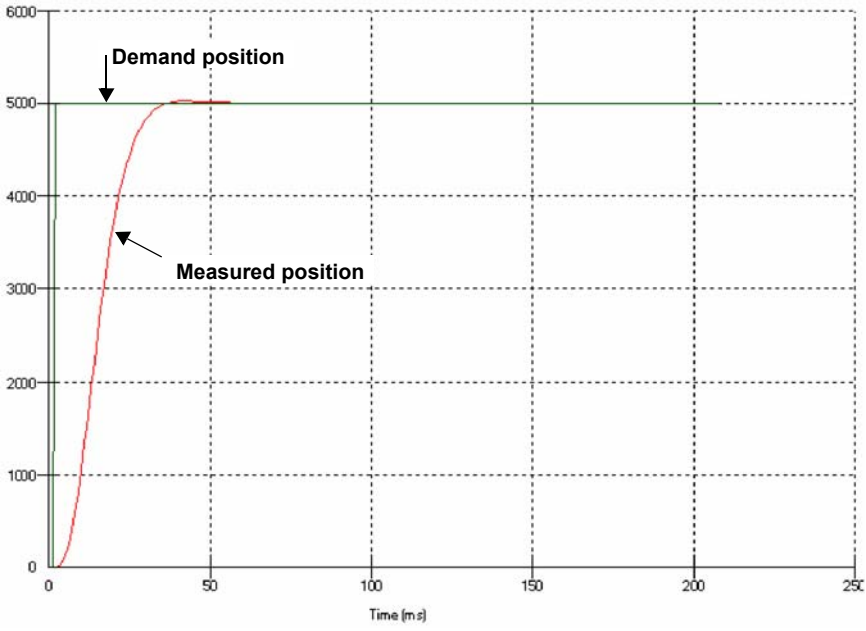


Figure 37: Critically damped (ideal) response

5.8 Servo axis - tuning for velocity control

Drive amplifiers designed for velocity control incorporate their own velocity feedback term to provide system damping. For this reason, KDERIV (and KVEL) can often be set to zero.

Correct setting of the velocity feed forward gain KVELFF is important to get the optimum response from the system. The velocity feed forward term takes the instantaneous velocity demand from the profile generator and adds this to the output block (see Figure 34). KVELFF is outside the closed loop and therefore does not have an effect on system stability. This means that the term can be increased to maximum without causing the motor to oscillate, provided that other terms are setup correctly.

When setup correctly, KVELFF will cause the motor to move at the speed demanded by the profile generator. This is true without the other terms in the closed loop doing anything except compensating for small errors in the position of the motor. This gives faster response to changes in demand speed, with reduced following error.

Before proceeding, confirm that the encoder feedback signals from the motor or drive amplifier have been connected, and that a positive demand causes a positive feedback signal.

5.8.1 Calculating KVELFF

To calculate the correct value for KVELFF, you will need to know:

- The speed, in revolutions per minute, produced by the motor when a maximum demand (+10 V) is applied to the drive amplifier.
- The setting for `LOOPTIME`. The factory preset setting is 1 ms.
- The resolution of the encoder input.

The servo loop formula uses speed values expressed in quadrature counts per servo loop. To calculate this figure:

1. First, divide the speed of the motor, in revolutions per minute, by 60 to give the number of revolutions per second. For example, if the motor speed is 3000 rpm when a maximum demand (+10 V) is applied to the drive amplifier:

   Revolutions per second = 3000 / 60
   = 50
2. Next, calculate how many revolutions will occur during one servo loop. The factory preset servo loop time is 1 ms (0.001 seconds), so:

   Revolutions per servo loop = 50 x 0.001 seconds
   = 0.05
3. Now calculate how many quadrature encoder counts there are per revolution. The NextMove ESB-2 counts both edges of both pulse trains (CHA and CHB) coming from the encoder, so for every encoder line there are 4 ‘quadrature counts’. With a 1000 line encoder:

   Quadrature counts per revolution = 1000 x 4
   = 4000
4. Finally, calculate how many quadrature counts there are per servo loop:

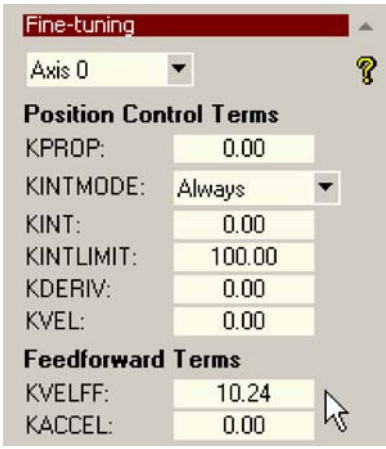
   Quadrature counts per servo loop = 4000 x 0.05
   = 200

The analog demand output is controlled by a 12-bit DAC, which can create output voltages in the range -10 V to +10 V. This means a maximum output of +10 V corresponds to a DAC value of 2048. The value of KVELFF is calculated by dividing 2048 by the number of quadrature counts per servo loop, so:

KVELFF = 2048 / 200
= **10.24**

5. Click in the KVELFF box and enter the value.

   The calculated value should give zero following error at constant velocity. Using values greater than the calculated value will cause the controller to have a following error ahead of the desired position. Using values less than the calculated value will cause the controller to have following error behind the desired position.



6. In the Move Type drop down box, check that the move type is set to Trapezoid.

7. Click in the Distance box and enter a distance for the step move. It is recommended to set a value that will cause the motor to make a few revolutions, for example 10.

Note: The distance depends on the scale set in section 5.4.2. If you set a scale so that units could be expressed in revolutions (or other unit of your choice), then those are the units that will be used here. If you did not set a scale, the amount you enter will be in encoder counts.

8. Click **Go**.

The NextMove ESB-2 will perform the move and the motor will turn. As the soon as the move is completed, Mint WorkBench will upload captured data from the NextMove ESB-2. The data will then be displayed in the Capture window as a graph.

Note: The graph that you see will not look exactly the same as the graph shown here! Remember that each motor has a different response.

9. Using the check boxes below the graph, select the Measured velocity and Demand velocity traces.

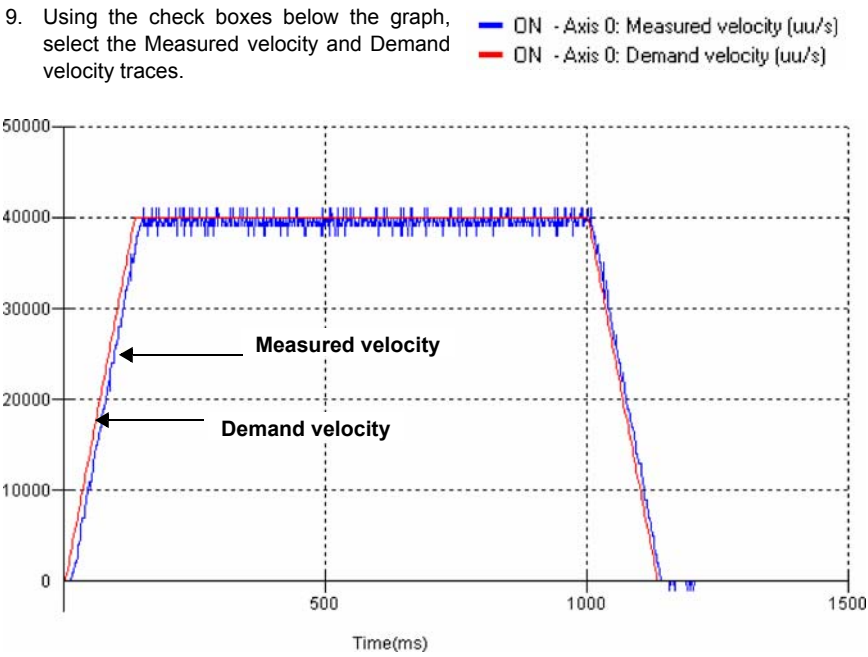


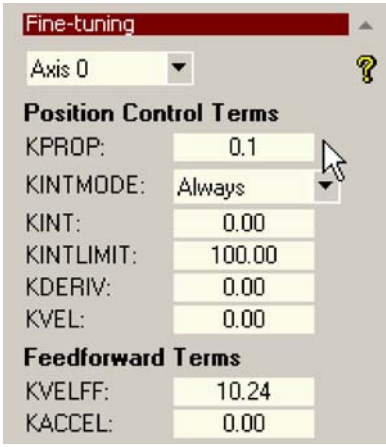
Figure 38: Correct value of KVELFF

It may be necessary to make changes to the calculated value of KVELFF. If the trace for Measured velocity appears above the trace for Demand velocity, reduce the value of KVELFF. If the trace for Measured velocity appears below the trace for Demand velocity, increase the value of KVELFF. Repeat the test after each change. When the two traces appear on top of each other (approximately), the correct value for KVELFF has been found as shown in Figure 38.

5.8.2 Adjusting KPROP

The KPROP term can be used to reduce following error. Its value will usually be much smaller than the value used for an equivalent current controlled system. A fractional value, for example 0.1, will probably be a good starting figure which can then be increased slowly.

1. Click in the KPROP box and enter a starting value of 0.1.

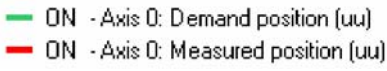


2. Click **Go**.

The NextMove ESB-2 will perform the move and the motor will turn. As the soon as the move is completed, Mint WorkBench will upload captured data from the NextMove ESB-2. The data will then be displayed in the Capture window as a graph.

Note: The graph that you see will not look exactly the same as the graph shown here! Remember that each motor has a different response.

3. Using the check boxes below the graph, select the Measured position and Demand position traces.



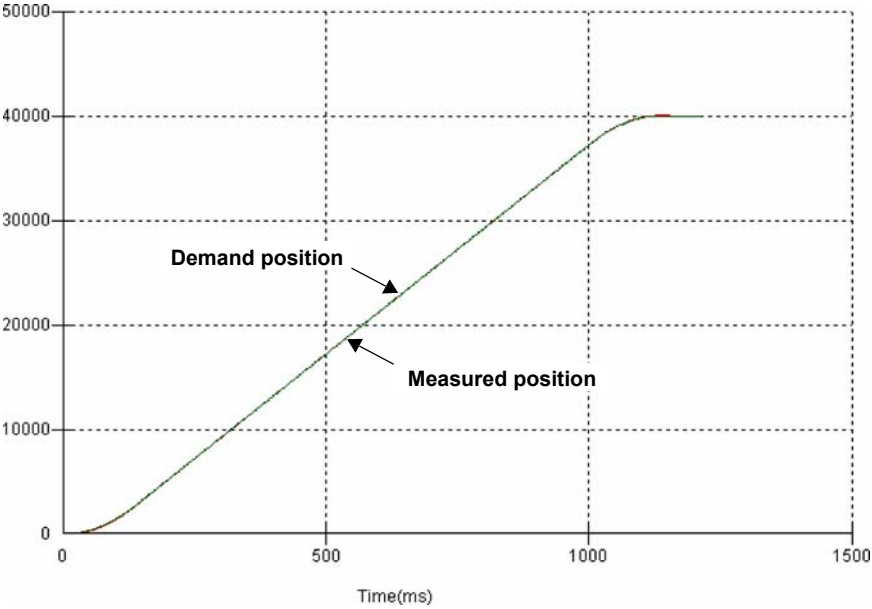


Figure 39: Correct value of KPROP

The two traces will probably appear with a small offset from each other, which represents the following error. Adjust KPROP by small amounts until the two traces appear on top of each other (approximately), as shown in Figure 39.

Note: It may be useful to use the zoom function to magnify the end point of the move. In the graph area, click and drag a rectangle around the end point of the traces. To zoom out, right-click in the graph area and choose Undo Zoom.

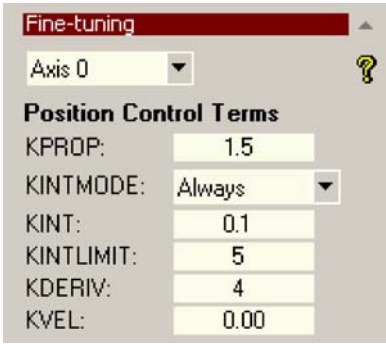
5.9 Servo axis - eliminating steady-state errors

In systems where precise positioning accuracy is required, it is often necessary to position within one encoder count. Proportional gain, KPROP, is not normally able to achieve this because a very small following error will only produce a small demand for the drive amplifier which may not be enough to overcome mechanical friction (this is particularly true in current controlled systems). This error can be overcome by applying integral gain. The integral gain, KINT, works by accumulating following error over time to produce a demand sufficient to move the motor into the required position with zero following error. KINT can therefore overcome errors caused by gravitational effects such as vertically moving linear axes. With current controlled drive amplifiers a non-zero demand output is required to hold the load in the correct position, to achieve zero following error.

Care is required when setting KINT since a high value will cause instability during moves.
A typical value for KINT would be 0.1. The effect of KINT should also be limited by setting the integration limit, KINTLIMIT, to the smallest possible value that is sufficient to overcome friction or static loads, for example 5. This will limit the contribution of the integral term to 5% of the full demand output range.

1. Click in the KINT box and enter a small starting value, for example 0.1.

2. Click in the KINTLIMIT box and enter a value of 5.



With NextMove ESB-2, the action of KINT and KINTLIMIT can be set to operate in various modes:

- Never - the KINT term is never applied
- Always - the KINT term is always applied
- Smart - the KINT term is only applied when the demand speed is zero or constant.
- Steady State - the KINT term is only applied when the demand speed is zero.

This function can be selected using the KINTMODE drop down box.

5.10 Digital input/output configuration

The Digital I/O window can be used to setup other digital inputs and outputs.

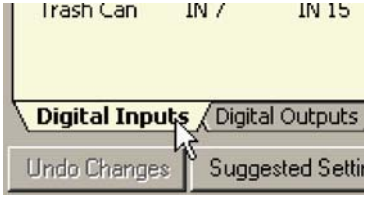
5.10.1 Digital input configuration

The Digital Inputs tab allows you to define how each digital input will be triggered, and if it should be assigned to a special purpose function such as a Home or Limit input. In the following example, digital input 1 will be set to trigger on an active low input, and allocated to the forward limit input of axis 0:

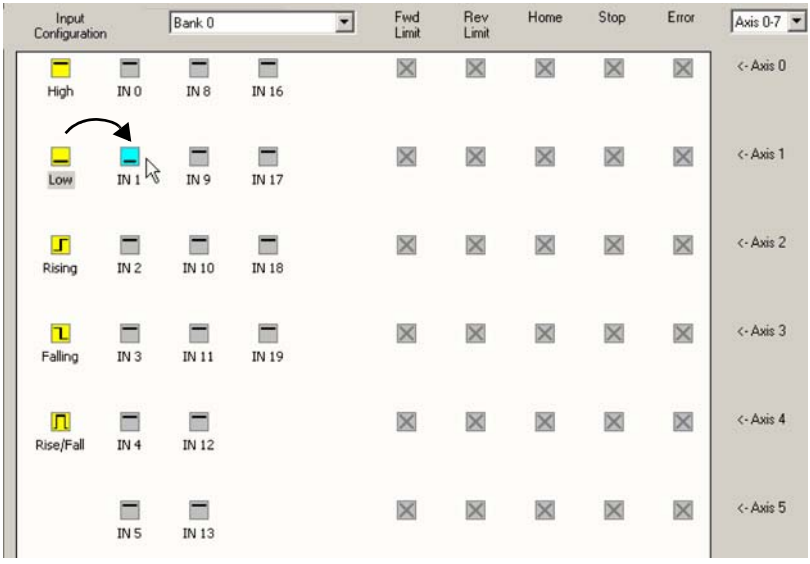
1. In the Toolbox, click the Digital I/O icon.

2. At the bottom of the Digital I/O screen, click the **Digital Inputs** tab.

   The left of the screen shows a column of yellow icons - High, Low, Rising, Falling and Rise/Fall. These describe how the input will be triggered.



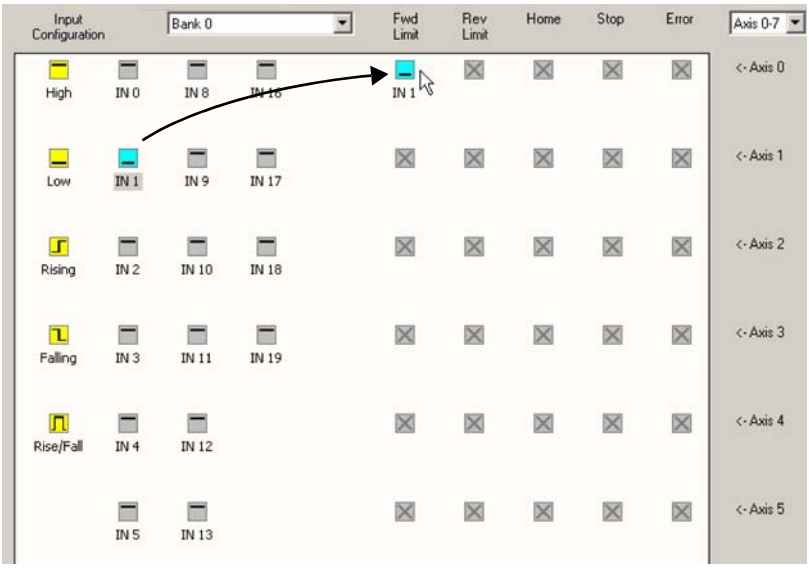
3. Drag the **Low** icon onto the **IN1** icon. This will setup **IN1** to respond to a low input.



4. Now drag the **IN1** icon

onto the **Fwd Limit** icon

.
This will setup IN1 as the Forward Limit input of axis 0.



5. Click **Apply** to send the changes to the NextMove ESB-2.

If required, multiple inputs can be configured before clicking **Apply**.

5.10.2 Digital output configuration

The Digital Outputs tab allows you to define how each digital output will operate and if it is to be configured as a drive enable output (see section 5.4.3). Remember to click **Apply** to send the changes to the NextMove ESB-2.

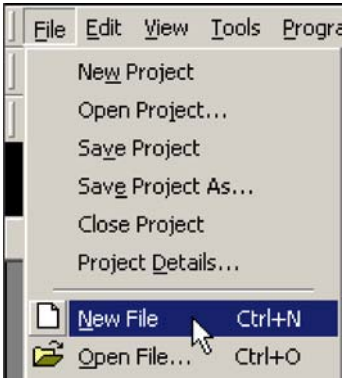
5.11 Saving setup information

When power is removed from the NextMove ESB-2 all data, including configuration and tuning parameters, is lost. You should therefore save this information in a file, which can be loaded when the unit is next used.

1. In the Toolbox, click the Edit & Debug icon.

2. On the main menu, choose **File**, **New File**.

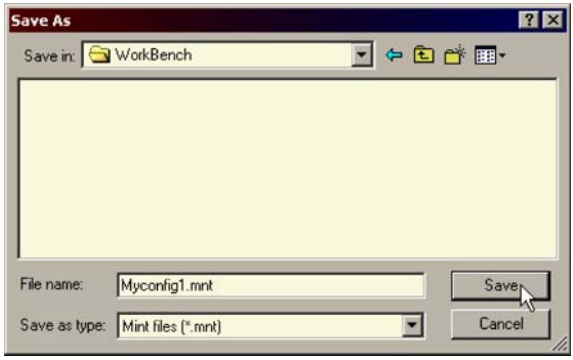
   A new program editing window will appear.



3. On the main menu, choose **Program**, **Generate Mint Startup Block**.

   Mint WorkBench will read all the configuration information from the NextMove ESB-2 and place it in a Startup block. For details of the Startup block, see the Mint help file.

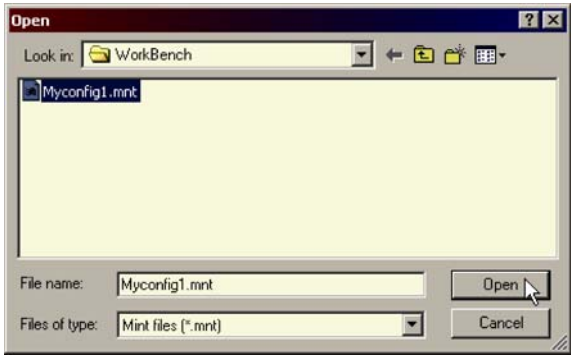
4. On the main menu, choose **File**, **Save File**. Locate a folder, enter a filename and click **Save**.



5.11.1 Loading saved information

1. In the Toolbox, click the Edit & Debug icon.

2. On the main menu, choose **File**, **Open File...** .
   Locate the file and click **Open**.



A Startup block should be included in every Mint program, so that whenever a program is loaded and run the NextMove ESB-2 will be correctly configured. Remember that every drive/motor combination has a different response. If the same program is used on a different NextMove ESB-2 installation, the Startup block will need to be changed.

6.1 Introduction

This section explains common problems and their solutions. If you want to know the meaning of the LED indicators, see section 6.2.

6.1.1 Problem diagnosis

If you have followed all the instructions in this manual in sequence, you should have few problems installing the NextMove ESB-2. If you do have a problem, read this section first.
In Mint WorkBench, use the Error Log tool to view recent errors and then check the help file.
If you cannot solve the problem or the problem persists, the SupportMe feature can be used.

6.1.2 SupportMe feature

The SupportMe feature is available from the Help menu, or by clicking the button on the motion toolbar. SupportMe can be used to gather information which can then be e-mailed, saved as a text file, or copied to another application. The PC must have e-mail facilities to use the e-mail feature. If you prefer to contact Baldor technical support by telephone or fax, contact details are provided at the front of this manual. Please have the following information ready:

- The serial number of your NextMove ESB-2 (if known).
- Use the Help, SupportMe menu item in Mint WorkBench to view details about your system.
- The type of drive amplifier and motor that you are using.
- A clear description of what you are trying to do, for example performing fine-tuning.
- A clear description of the symptoms that you can observe, for example error messages displayed in Mint WorkBench, or the current value of any of the Mint error keywords `AXISERROR`, `AXISSTATUS`, `INITERROR`, and `MISCERROR`.
- The type of motion generated in the motor shaft.
- Give a list of any parameters that you have setup, for example the gain settings you have entered.

6.2 NextMove ESB-2 indicators

6.2.1 Status display

The Status LED normally displays the unit's node number. To display information about a specific axis, use the LED keyword (see the Mint help file). When a specific axis is selected, the following symbols may be displayed by the Status LED. Some characters will flash to indicate an error.

2	Spline. A spline move is being performed. See the SPLINE keyword and related commands.
8	Axis enabled.
9	Torque mode. The NextMove ESB-2 is in Torque mode. See the TORQUE keyword and related commands.
A	Hold to Analog. The axis is in Hold To Analog mode. See the HTA keyword and related commands.
d	Follow and offset. When an axis is following a demand signal it may be necessary to advance or retard the slave in relation to the master. To do this an offset move is performed in parallel with the follow. See the FOLLOW and OFFSET keywords.
C	Circle. A circle move is being performed. See the CIRCLEA or CIRCLER keywords.
c	Cam. A Cam profile is being profiled. See the CAM keyword.
E.	General error. See the AXISERROR keyword. The motion toolbar displays the status of AXISERROR, which is a bit pattern of all latched errors. See also the Error Log topics in the help file.
E.	Error input. The ERRORINPUT has been activated and generated an error.
F	Flying shear. A flying shear is being profiled. See the FLY keyword.
F.	Position following error. A following error has occurred. See the AXISERROR keyword and associated keywords. Following errors could be caused by a badly tuned drive/motor. At higher acceleration and deceleration rates, the following error will typically be greater. Ensure that the drive/motor is adequately tuned to cope with these acceleration rates. The following error limit can be adjusted to suit your application (see the FOLERRORFATAL and VELFATAL keywords). Following error could also be the cause of encoder/resolver loss (see also the FEEDBACKFAULTENABLE keyword).
F	Follow mode. The axis is in Follow mode. See the FOLLOW keyword.
h	Homing. The axis is currently homing. See the HOME keyword.
I	Incremental move. An incremental move is being profiled. See the INCA and INCR keywords.
J	Jog. The axis is jogging. In the Mint help file, see the topics JOG, JOGCOMMAND and Jog mode.

o	Offset move. The axis is performing an offset move.
P	Positional Move. The axis is performing a linear move. See the MOVEA and MOVER keywords.
S	Stop. A STOP command has been issued or the stop input is active.
-	Axis disabled. The axis/drive must be enabled before operation can continue. See section 5.4.4. Click the Drive enable button in Mint WorkBench.
=	Suspend. The SUSPEND command has been issued and is active. Motion will be ramped to zero demand whilst active.
F.	Reverse software or hardware limit. A reverse software limit has been activated. See AXISERROR and/or AXISSTATUS to determine which applies.
4.	Forward software or hardware limit. A forward software limit has been activated. See AXISERROR and/or AXISSTATUS to determine which applies.
≡	Firmware being updated (horizontal bars appear sequentially). New firmware is being downloaded to the NextMove ESB-2.
1.	Initialization error. An initialization error has occurred at power on. See the Error Log or INITERROR topics in the help file. Initialization errors should not normally occur.

When a node number between 1 and 15 is displayed, it is shown in hexadecimal format (1 - F). For node numbers greater than 15, three horizontal bars are displayed. User defined symbols can be made to appear using the keywords LED and LEDDISPLAY. See the Mint help file for details of each keyword.

If the status display shows one of the digits 0 - 7 with a flashing decimal point during startup, this indicates that the NextMove ESB-2 has detected a fault and cannot be started. In this unlikely event, please contact Baldor technical support.

6.2.2 Communication

If the problem is not listed below please contact Baldor technical support.

Symptom	Check
Cannot detect NextMove ESB-2	Check that the NextMove ESB-2 is powered. For serial connections, check that the serial cable is wired correctly and properly connected. Check that no other application on the PC is attempting to use the same serial port. For USB connections, check that the cable is properly connected. Check the USB connector socket pins for damage or sticking. Check that the USB device driver has been installed; a “USB Motion Controller” device should be listed in Windows Device Manager.
Cannot communicate with the controller.	Verify that Mint WorkBench is loaded and that NextMove ESB-2 is the currently selected controller.

Symptom	Check
Cannot communicate with the controller after downloading firmware.	After firmware download, always power cycle the controller (remove 24 V power and then reconnect).

6.2.3 Motor control

If the problem is not listed below please contact Baldor technical support.

Symptom	Check
Controller appears to be working but will not cause motor to turn.	Check that the connections between motor and drive are correct. Use Mint WorkBench to perform the basic system tests (see sections 5.5 and 5.6). Confirm that the drive enable output has been configured (see section 5.4.3). Ensure that while the NextMove ESB-2 is not in error the drive is enabled and working. When the NextMove ESB-2 is first powered up the drive should be disabled if there is no program running (there is often an LED on the front of the drive to indicate status). (*Servo outputs only*) Check that the servo loop gains are setup correctly - check the Fine-tuning window. See sections 5.6.2 to 5.9.
Motor runs uncontrollably when controller is switched on.	Verify that the NextMove ESB-2 and drive are correctly grounded to a common ground. (*Servo outputs only*) Check that the correct encoder feedback signal is connected to the encoder input, the encoder has power (if required, see sections 4.4.3 and 7.1.8) and is functioning correctly. Check that the drive is connected correctly to the NextMove ESB-2 and that with zero demand there is 0 V at the drive's demand input. See section 5.6.1.

Symptom	Check
Motor runs uncontrollably when controller is switched on and servo loop gains are applied or when a move is set in progress. Motor then stops after a short time.	(*Servo outputs only*) Check that the encoder feedback signal(s) are connected to the correct encoder input(s). Check the demand to the drive is connected with the correct polarity. Check that for a positive demand signal, a positive increase in axis position is seen. The `ENCODERMODE` keyword can be used to change encoder input direction. The `DACMODE` keyword can be used to reverse DAC output polarity. Check that the maximum following error is set to a reasonable value. For setting up purposes, following error detection may be disabled by setting `FOLERRORMODE=0`.
Motor is under control, but vibrates or overshoots during a move.	(*Servo outputs only*) Servo loop gains may be set incorrectly. See sections 5.6.2 to 5.9.
Motor is under control, but when moved to a position and then back to the start it does not return to the same position.	Verify that the NextMove ESB-2 and drive are correctly grounded to a common ground point. (*Servo outputs only*) Check: ■ all encoder channels are free from electrical noise; ■ they are correctly wired to the controller; ■ when the motor turns, the two square wave signals are 90 degrees out of phase. Also check the complement signals. Ensure that the encoder cable uses shielded twisted pair cable, with the outer shield connected at both ends and the inner shields connected only at the NextMove ESB-2 end. (*Stepper outputs only*) The motor is not maintaining synchronization with the NextMove ESB-2 drive output signals due to excessive acceleration, speed or load demands on the motor. Check that the acceleration, speed and load are within the capabilities of the motor.

6.2.4 Mint WorkBench

Symptom	Check
The Spy window does not update	The system refresh has been disabled. Go to the Tools, Options menu item, select the System tab and then choose a System Refresh Rate (500 ms is recommended).
Firmware download fails	Confirm that you have the correct version of firmware. Attempting to download certain older versions of firmware (intended for models without USB), will cause the download to fail. Download the latest version of firmware.
Cannot communicate with the controller after downloading firmware.	After firmware download, always power cycle the controller (remove 24 V power and then reconnect).
Mint WorkBench loses contact with NextMove ESB-2 while connected using USB	Check that the NextMove ESB-2 is powered. Check that a “USB Motion Controller” device is listed in Windows Device Manager. If not, there could be a problem with the PC's USB interface.

6.2.5 CANopen

Symptom	Check
The CANopen bus is 'passive'	This means that the internal CAN controller in the NextMove ESB-2 is experiencing a number of Tx and/or Rx errors, greater than the passive threshold of 127. Check: ■ 12-24 V is being applied to pin 5 of the RJ45 CAN connector, to power the opto-isolators. ■ There is at least one other CANopen node in the network. ■ The network is terminated only at the ends, not at intermediate nodes. ■ All nodes on the network are running at the same baud rate. ■ All nodes have been assigned a unique node ID. ■ The integrity of the CAN cables. The NextMove ESB-2 should recover from the 'passive' state once the problem has been rectified (this may take several seconds).
The CANopen bus is 'off'	This means that the internal CAN controller in the NextMove ESB-2 has experienced a fatal number of Tx and/or Rx errors, greater than the off threshold of 255. At this point the node will have switched itself to a state whereby it cannot influence the bus. Check: ■ 12-24 V is being applied to pin 5 of the RJ45 CAN connector, to power the opto-isolators. ■ There is at least one other CANopen node in the network. ■ The network is terminated only at the ends, not at intermediate nodes. ■ All nodes on the network are running at the same baud rate. ■ All nodes have been assigned a unique node ID. ■ The integrity of the CAN cables. To recover from the 'off' state the bus must be reset. This can be done using the Mint BUSRESET keyword, or by resetting the NextMove ESB-2.

Symptom	Check
The Manager node cannot scan/recognize a node on the network using the Mint NODESCAN keyword.	Assuming that the network is working correctly (see previous symptoms) and the bus is in an 'Operational' state, check the following: ■ Only nodes that conform to DS401, DS403 and other Baldor CANopen nodes are supported by the Mint NODESCAN keyword. ■ Check that the node in question has been assigned a unique node ID. ■ The node must support the node guarding process. NextMove ESB-2 does not support the Heartbeat process. ■ Try power-cycling the node in question. If the node in question does not conform to DS401 or DS403 and is not a Baldor CANopen node, communication is still possible using a set of general purpose Mint keywords. See the Mint help file for further details.
The node has been successfully scanned / recognized by the Manager node, but communication is still not possible.	For communication to be allowed, a connection must be made to a node after it has been scanned. ■ Baldor controller nodes are automatically connected to after being scanned. ■ Nodes that conform to DS401, DS403 must have the connections made manually using the Mint CONNECT keyword. If a connection attempt using CONNECT fails then it may be because the node being connected to does not support an object which needs to be accessed in order to setup the connection.

6.2.6 Baldor CAN

Symptom	Check
The Baldor CAN bus is 'passive'	This means that the internal CAN controller in the NextMove ESB-2 is experiencing a number of Tx and/or Rx errors, greater than the passive threshold of 127. Check: ■ 12-24 V is being applied to pin 5 of the RJ45 CAN connector, to power the opto-isolators. ■ There is at least one other Baldor CAN node in the network, with jumpers JP1 and JP2 in the '1' (lower) position. ■ The network is terminated only at the ends, not at intermediate nodes. ■ All nodes on the network are running at the same baud rate. ■ All nodes have been assigned a unique node ID. ■ The integrity of the CAN cables. The NextMove ESB-2 should recover from the 'passive' state once the problem has been rectified.
The Baldor CAN bus is 'off'	This means that the internal CAN controller in the NextMove ESB-2 has experienced a fatal number of Tx and/or Rx errors, greater than the off threshold of 255. At this point the node will have switched itself to a state whereby it cannot influence the bus. Check: ■ 12-24 V is being applied to pin 5 of the RJ45 CAN connector, to power the opto-isolators. ■ There is at least one other Baldor CAN node in the network, with jumpers JP1 and JP2 in the '1' (lower) position. ■ The network is terminated only at the ends, not at intermediate nodes. ■ All nodes on the network are running at the same baud rate. ■ All nodes have been assigned a unique node ID. ■ The integrity of the CAN cables. To recover from the 'off' state the bus must be reset. This can be done using the Mint BUSRESET keyword, or by resetting the NextMove ESB-2.

7.1 Introduction

This section provides technical specifications of the NextMove ESB-2.

7.1.1 Input power

Description	**Value**
Input power	
Nominal input voltage	24 VDC (±20%)
Power consumption	50 W (2 A @24 V approx.)

7.1.2 Analog inputs

Description	**Unit**	**Value**
Type		Differential
Common mode voltage range	**VDC**	±10
Input impedance	**kΩ**	120
Input ADC resolution	**bits**	12 (includes sign bit)
Equivalent resolution (±10 V input)	**mV**	±4.9
Sampling interval	**µs**	500 (both inputs enabled) 250 (one input disabled)

7.1.3 Analog outputs

Description	**Unit**	**Value**
Type		Bipolar
Output voltage range	**VDC**	±10
Output current (per output)	**mA**	2.5
Output DAC resolution	**bits**	12
Equivalent resolution	**mV**	±4.9
Update interval	**µs**	100 - 2000 (same as `LOOPTIME`; default = 1000)

7.1.4 Digital inputs

Description	**Unit**	**Value**
Type		Opto-isolated
USR V+ supply voltage Nominal Minimum Maximum	**VDC**	 24 12 30
Input voltage Active Inactive	**VDC**	 > 12V < 2V
Input current Maximum per input, USR V+ = 24 V	**mA**	 7

7.1.5 Digital outputs - general purpose

Description	**Unit**	**Value**	
USR V+ supply voltage Nominal Minimum Maximum	**VDC**	 24 12 30	
Output current Max. source per output, one output on Max. source per output, all outputs on Maximum total output current	**mA**	DOUT0-7 350 62.5 500	DOUT8-11 350 125 500
Update interval (Mint)		Immediate	
Switching time No load on output With 7 mA or greater load		 100 ms 10 µs	

7.1.6 Relay output

Description	**Unit**	**Value**
Contact rating (resistive)		1 A @ 24 VDC or 0.25 A @ 30 VAC
Operating time (max)	**ms**	5

7.1.7 Stepper control outputs

Models NSB202... / NSB204...

Description	Unit	Value
Output type		RS422 (differential) step (pulse) and direction
Maximum output frequency	**kHz**	500
Output current Maximum, per output pair	**mA**	20

Models NSB203... / NSB205...

Description	Unit	Value
Output type		Open collector step (pulse) and direction
Maximum output frequency	**kHz**	500
Output current Maximum sink, per output	**mA**	50

7.1.8 Encoder inputs

Description	Unit	Value
Encoder input		RS422 A/B Differential, Z index
Maximum input frequency	**MHz**	10 (quadrature)
Output power supply to encoders		5 V (±5%) 250 mA (per encoder)
Maximum allowable cable length		30.5 m (100 ft)

7.1.9 Serial RS232/RS485 port

Description	Unit	Value
Signal		RS232 non-isolated CTS/RTS or RS485 non-isolated (model dependent)
Bit rates	**baud**	9600, 19200, 38400, 57600 (default), 115200 (RS232 only)

7.1.10 CAN interface

Description	Unit	Value
Signal		2-wire, isolated
Channels		1
Protocols		CANopen or Baldor CAN (selected by choice of firmware)
Bit rates CANopen Baldor CAN	**Kbit/s**	 10, 20, 50, 100, 125, 250, 500, 1000 10, 20, 50, 125, 250, 500, 1000

7.1.11 Environmental

Description	Unit	Value	
Operating temperature range		**Min**	**Max**
	°C	0	+45
	°F	+32	+113
Maximum humidity	**%**	80% for temperatures up to 31 °C (87 °F) decreasingly linearly to 50% relative humidity at 45 °C (113 °F), non-condensing (according to DIN40 040 / IEC144)	
Maximum installation altitude (above m.s.l.)	**m**	2000	
	ft	6560	

See also section 3.1.1.

7.1.12 Weights and dimensions

Description	Unit	Value
Weight		Approximately 700 g (1.5 lb)
Nominal overall dimensions		245 mm x 140 mm x 45 mm (9.65 in x 5.51 in x 1.77 in)

7.1.13 Declaration of Conformity

CE BALDOR CE

Date: 14/01/08 **EC Declaration of Conformity** **Ref: DE00029-000**

Manufacturer: Baldor UK Ltd.
Address: Mint Motion Centre, 6 Bristol Distribution Park, Hawkley Drive, Bristol, BS32 0BF, United Kingdom.

Hereby declare that the product:

NextMove ESB2 Multi-Axis Motion Controller, being one of:

NSB20X-XXX (*where* X-XXX = *Product Variant*)

when used in accordance with the guidance given in the corresponding NextMove ESB2 Installation Manual, MN1957, conforms with the protection requirements of the following Council Directives, by application of the relevant harmonised standards:-

The Electromagnetic Compatibility Directive 2004/108/EC and its amending directives:-

Standard:	**Title:**
EN 61000-6-2 : 2005	Generic Standard - Immunity Standard for Industrial Environments
EN 61000-6-4 : 2007	Generic Standard - Emission Standard for Industrial Environments

and in detail with the following basic standards:

Standard:	**Title:**
EN 61000-4-4 : 2004	EFT/Bursts
EN 61000-4-2 : 1995+A1+A2	Electrostatic Discharge
IEC 61000-4-3 : 2002	RF Immunity
IEC 61000-4-6 : 2003	RF Common Mode

EC Declaration of Incorporation

The Machinery Directive 98/37/EC and its amending directives:-

The above product is intended to be incorporated into machinery or to be assembled with other machinery to constitute machinery covered by directive 98/37/EC.
As such does therefore not in every respect comply with the provisions of directive 98/37/EC.

Users must follow the guidance given in this directive to meet all necessary protection requirements. All instructions, warnings & safety information of the product manual MN1957 must be adhered to. User must follow the guidance given in harmonised standard EN60204-1 (Safety of Machinery) to meet necessary protection requirements of this directive.

Furthermore it is declared that it may not be put into service before the machinery in which it will be incorporated is declared to comply with the provisions of directive 98/37/EC, as amended.

Signed: .....

Dr. Gerry Boast
Engineering Manager

A.1 Introduction

A variety of accessories are available to expand the capabilities of the NextMove ESB-2.

A.1.1 Feedback cables

The Baldor cables listed in Table 3 connect the 'Encoder Out' signal from a drive amplifier (for example MicroFlex, FlexDrive^{II}, Flex+Drive^{II}, or MintDrive^{II}) to the 'ENC 0' - 'ENC 4' encoder input connectors on the NextMove ESB-2. One cable is required for each servo axis. See section 4.4.3 for the connector pin configuration.

Cable assembly description	Baldor catalog number	Length	
		m	ft
Drive Amplifier to NextMove ESB Feedback Cable, with 9-pin D-type male connectors at both ends	CBL015MF-E3B*	1.5	5
	CBL025MF-E3B	2.5	8.2
	CBL030MF-E3B*	3.0	10
	CBL050MF-E3B	5.0	16.4
	CBL061MF-E3B*	6.1	20
	CBL075MF-E3B	7.5	24.6
	CBL091MF-E3B*	9.1	30
	CBL100MF-E3B	10	32.8
	CBL150MF-E3B	15	49.2
	CBL152MF-E3B*	15.2	50
	CBL200MF-E3B	20	65.6
	CBL229MF-E3B*	22.9	75

* Available in North and South America only.

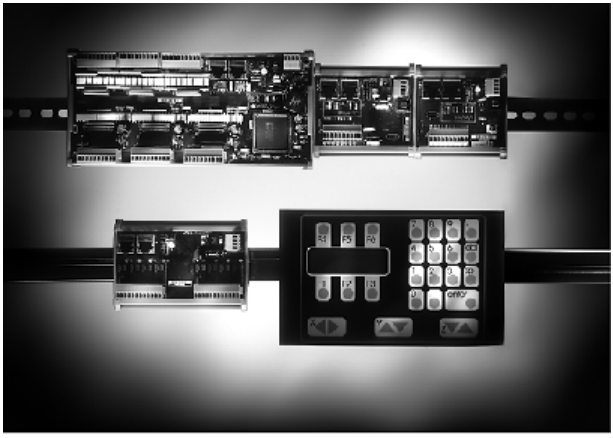
Table 3: Drive amplifier to NextMove ESB-2 feedback cables

If you are not using a Baldor cable, be sure to obtain a cable that is a shielded twisted pair 0.34 mm^2 (22 AWG) wire minimum, with an overall shield. Ideally, the cable should not exceed 30.5 m (100 ft) in length. Maximum wire-to-wire or wire-to-shield capacitance is 50 pF per 300 mm (1 ft) length, to a maximum of 5000 pF for 30.5 m (100 ft).

A.1.2 Baldor CAN nodes

Digital I/O can be expanded easily on NextMove ESB-2 using the Baldor CAN (CAN2) connection. This provides a high speed serial bus interface to a range of I/O devices, including:

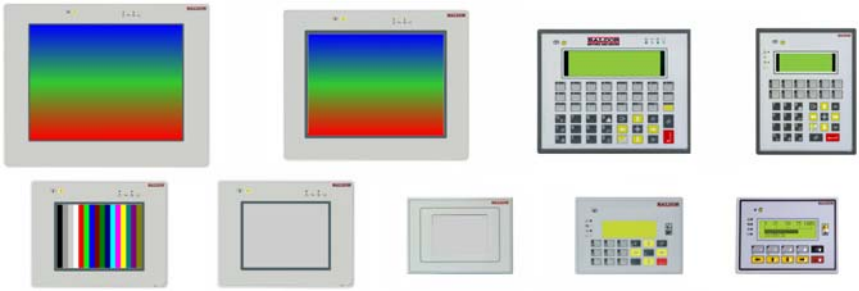
- *inputNode 8*: 8 opto-isolated digital inputs.
- *relayNode 8*: 8 relay outputs.
- *outputNode 8*: 8 opto-isolated digital outputs with short circuit and over current protection.
- *ioNode 24/24*: 24 opto-isolated input and 24 opto-isolated outputs.
- *keypadNode*: General purpose operator panel (3 and 4 axis versions).



Catalog number	Description
ION001-501	8 digital inputs
ION002-501	8 relay outputs
ION003-501	8 digital outputs
ION004-501	24 digital inputs and 24 digital outputs
KPD002-501	27 key keypad and 4 line LCD display
KPD002-505	41 key keypad and 4 line LCD display

A.1.3 HMI panels

A range of programmable HMI (Human Machine Interface) panels are available with serial or CANopen communication. Some have color and/or touchscreen capabilities, and all may be programmed using the dedicated HMI Designer software.



Catalog number	Description
KPD-KG420-20	4x20 character/graphic display, serial interface
KPD-KG420-30	4x20 character/graphic display, 12 function keys, serial interface
KPD-TS03M-10	3.9" monochrome touch screen with serial interface
KPD-TS05M-10	5.6" monochrome touch screen with serial interface
KPD-TS05C-30	5.6" color TFT touch screen with serial interface
KPD-TS05C-30E	5.6" color TFT touch screen with serial interface and Ethernet
KPD-TS10C-30E	10" color TFT touch screen with serial interface and Ethernet
KPD-TS12C-30E	12.1" color TFT touch screen with serial interface and Ethernet

A.1.4 Baldor keypad

The Baldor keypad provides an easy to use operator interface for controlling machinery. It has a 4x20 character display and can be connected using either the serial or CANopen interface.

A.1.5 Mint NC (CAD to motion software)

The Mint NC software provides machine builders with an extremely rapid and flexible solution for creating contouring and profiling machinery and automation. Mint NC provides a PC-based environment that will import information in industry-standard CAD formats including G-code, HPGL and DXF, and generate the required real-time motion commands.

B.1 Introduction

The following table summarizes the Mint keywords supported by the NextMove ESB-2. Note that due to continuous developments of the NextMove ESB-2 and the Mint language, this list is subject to significant change. Check the latest Mint help file for full details of new or changed keywords.

B.1.1 Keyword listing

Keyword	Description
ABORT	To abort motion on all axes.
ABORTMODE	To control the default action taken in the event of an abort.
ACCEL	To define the acceleration rate of an axis.
ACCELDEMAND	To read the instantaneous demand acceleration.
ACCELJERK	To define the jerk rate to be used during periods of acceleration.
ACCELJERKTIME	To define the jerk rate to be used during periods of acceleration.
ACCELTIME	To define the acceleration rate of an axis.
ACTIVERS485NODE	Enables the transmitter on a controller's RS485 port.
ADC	To read an analog input value.
ADCERROR	To read back the analog inputs currently in error.
ADCERRORMODE	Controls the default action taken in the event of an ADC limit being exceeded on an associated channel.
ADCGAIN	To set the gain to be applied to an ADC input.
ADCMAX	Sets the upper analog limit value for the specified analog input.
ADCMIN	Sets the lower analog limit value for the specified analog input.
ADCMODE	To set the analog input mode.
ADCMONITOR	Specifies the analog inputs that an axis will monitor for analog limit checking.
ADCOFFSET	To set the offset to be applied to an ADC input.
ADCTIMECONSTANT	To set the time constant of the low pass filter applied to an ADC input.
ASYNCERRORPRESENT	To determine whether an asynchronous error is present.
AUXDAC	To set or read the auxiliary DAC outputs.
AUXENCODER	To set or read the auxiliary encoder input.

Keyword	Description
AUXENCODERMODE	To make miscellaneous changes to the auxiliary encoders.
AUXENCODERPRESCALE	To scale down the auxiliary encoder input.
AUXENCODERSCALE	To set or read the scale factor for the auxiliary encoder input.
AUXENCODERVEL	To read the velocity of the auxiliary encoder input.
AUXENCODERWRAP	To set or read the encoder wrap range for the auxiliary encoder input.
AUXENCODERZLATCH	To read the state of the auxiliary encoder's Z latch.
AXISCHANNEL	Allows user mapping of hardware to axis numbers.
AXISERROR	To read back the motion error.
AXISMODE	To return the current mode of motion.
AXISSTATUS	To return the current error status from the specified axis.
AXISVELENCODER	To select the source of the velocity signal used in dual encoder feedback systems.
AXISWARNING	To read or clear present axis warnings.
AXISWARNINGDISABLE	Allows individual axis warnings to be enabled and disabled.
BACKLASH	To set the size of the backlash present on an axis.
BACKLASHINTERVAL	To set the rate at which backlash compensation is applied.
BACKLASHMODE	Controls the use of backlash compensation.
BLEND	To start blending the current move with the next move in the buffer.
BLENDDISTANCE	To specify the distance, before the end of the vector path, where blending will begin.
BLENDMODE	To enable blending for interpolated moves.
BOOST	To control the stepper boost outputs.
BUSBAUD	To specify the bus baud rate.
BUSEVENT	Returns the next event in the bus event queue of a specific bus.
BUSEVENTINFO	Returns the additional information associated with a bus event.
BUSNODE	To set or read the node ID used for the specified bus.
BUSRESET	Resets the bus controller.
BUSSTATE	Returns the status of the bus controller.
CAM	Perform a cam profile.
CAMAMPLITUDE	To modify the amplitude of a cam profile.
CAMBOX	To start or stop a CAMBox channel.
CAMBOXDATA	To load data associated with a CAMBox channel.
CAMEND	To define an end point in the cam table if multiple cams are required.

Keyword	Description
CAMINDEX	Returns the currently executing cam segment number.
CAMPHASE	Allows a cam profile to be shifted forwards or backwards over a fixed number of cam segments.
CAMPHASESTATUS	To get the state of the CAMPHASE for a specific axis.
CAMSEGMENT	To change CAM table data.
CAMSTART	To define a start point in the cam table if multiple cams are required.
CAMTABLE	To specify the array names to be used in a cam profile on the specified axis.
CANCEL	To stop motion and clear errors on an axis.
CANCELALL	To stop motion and clear errors on all axes.
CAPTURE	Controls the operation of capture.
CAPTURECHANNEL-UPLOAD	To allow an entire channel of captured data values to be uploaded into an array.
CAPTUREDURATION	To define the total duration of the data capture.
CAPTUREEVENT	Configures capturing to stop on an event.
CAPTUREEVENTAXIS	Sets the axis to monitor for the capture trigger event.
CAPTUREEVENTDELAY	Defines the post-trigger delay for event capture.
CAPTUREINTERVAL	To define the interval between data captures, relative to the servo frequency.
CAPTUREMODE	To set or read the mode on a capture channel.
CAPTUREMODE-PARAMETER	To specify a parameter associated with CAPTUREMODE.
CAPTURENUMPOINTS	To read the number of captured points per channel.
CAPTUREPERIOD	To define the interval between data captures.
CAPTUREPOINT	To allow individual capture values to be read.
CHANNELTYPE	To determine what hardware is available to a specific channel.
CIRCLEA	To perform a circular move with absolute co-ordinates.
CIRCLER	To perform a circular move with relative co-ordinates.
COMMS	Accesses the reserved comms array.
COMMSMODE	Selects comms use over either RS485 or CANopen.
COMMSRETRIES	To set the maximum number of re-tries for a RS485/422 comms telegram.
COMPAREENABLE	Enables/disables the position compare control of a specific digital output.
COMPARELATCH	To read the state of the position compare latch.
COMPAREOUTPUT	To specify the digital output used for position compare.

Keyword	Description
COMPAREPOS	To write to the position compare registers.
CONFIG	To set the configuration of an axis for different control types.
CONNECT	To enable a connection between two remote nodes to be made or broken.
CONNECTSTATUS	Returns the status of the connection between this node and another node.
CONTOURMODE	To enable contouring for interpolated moves.
CONTOURPARAMETER	To set the parameters for contoured moves.
DAC	To write a value to the DAC or read the present DAC value.
DACLIMITMAX	To restrict the DAC output voltage to a defined range.
DACMODE	To control the use of the DAC.
DACMONITORAXIS	To specify which axis to monitor during DAC monitoring.
DACMONITORGAIN	To specify a multiplying factor for use during DAC monitoring.
DACMONITORMODE	To specify which axis parameter to monitor during DAC monitoring.
DACOFFSET	Apply a voltage offset to a DAC channel.
DACRAMP	To specify the number of milliseconds over which the maximum DAC output will be ramped to zero.
DECEL	To set the deceleration rate on the axis.
DECELJERK	To define the jerk rate to be used during periods of deceleration.
DECELJERKTIME	To define the jerk rate to be used during periods of deceleration.
DECELTIME	To set the deceleration rate on the axis.
DEFAULT	To return axis motion variables to their power-up state.
DEFAULTALL	To return all axis motion variables to their power-up state.
DPREVENT	To interrupt the host PC and generate a trappable event, using the Dual Port RAM (DPR).
DRIVEENABLE	To enable or disable the drive for the specified axis.
DRIVEENABLEOUTPUT	To specify an output as a drive enable.
ENCODER	To set or read the axis encoder value.
ENCODERMODE	To make miscellaneous changes to the encoders.
ENCODERPRESCALE	To scale down the encoder input.
ENCODERSCALE	To set or read the scale factor for the encoder channel.
ENCODERVEL	To read the velocity from an encoder channel.
ENCODERWRAP	To set or read the encoder wrap range for the encoder channel.

Keyword	Description
ENCODERZLATCH	To get and reset the state of an axis' encoder Z latch.
ERRORDECEL	To set the deceleration rate on the axis for powered stops, in the event of an error or stop input.
ERRORINPUT	To set or return the digital input to be used as the error input for the specified axis.
ERRORINPUTMODE	To control the default action taken in the event of an external error input.
ERRORMASK	To prevent specific error conditions calling the ONERROR event.
EVENTACTIVE	Indicates whether an event is currently active.
EVENTDISABLE	To selectively enable and disable Mint events.
EVENTPENDING	To indicate whether an event is currently pending.
FACTORYDEFAULTS	To reset parameter table entries to their default values.
FASTAUXENABLE	To manually clear the auxiliary encoder's fast position latch.
FASTAUXENCODER	To return the instantaneous auxiliary encoder value that was recorded on the fast interrupt.
FASTAUXLATCH	To read the auxiliary encoder fast interrupt latch.
FASTAUXLATCHMODE	Sets the default action to be taken to clear the auxiliary encoder's fast position latch.
FASTAUXSELECT	To select which of the fast position capture inputs will capture an auxiliary encoder channel.
FASTENABLE	Manually clears the encoder's fast position latch.
FASTENCODER	To return the instantaneous encoder value that was recorded on the fast interrupt.
FASTLATCH	To read the axis fast interrupt latch.
FASTLATCHDISTANCE	To specify the distance over which further position latch edges will be ignored.
FASTLATCHEDGE	To define which edge polarity should cause the fast position to be captured.
FASTLATCHMODE	To set the default action to be taken to clear the encoder's fast position latch.
FASTPOS	To return the instantaneous axis position that was recorded on the fast interrupt.
FASTSELECT	To select which of the fast position capture inputs (or outputs) will cause axis position to be captured.
FASTSOURCE	To select whether fast position capture is triggered by a digital input or a digital output.
FEEDRATE	To set the slew speed of an individual move loaded in the move buffer.

Keyword	Description
FEEDRATEMODE	To control the use of slew speed, acceleration, deceleration and feedrate override.
FEEDRATEOVERRIDE	Overrides the current speed or feedrate being used.
FEEDRATEPARAMETER	To set the parameters for the current speed or feedrate being used.
FIRMWARERELEASE	To read the release number of the firmware.
FLY	To create a flying shear by following a master axis with controlled acceleration and deceleration.
FOLERROR	To return the instantaneous following error value.
FOLERRORFATAL	To set the maximum permissible following error before an error is generated.
FOLERRORMODE	To determine the action taken on the axis in the event of a following error.
FOLERRORWARNING	Sets the following error threshold before an axis warning is generated.
FOLLOW	To enable encoder following with a specified gear ratio.
FOLLOWMODE	To define the mode of operation of the FOLLOW keyword.
FREQ	To set a constant frequency output.
GEARING	To set the percentage size for gearing compensation.
GEARINGMODE	To turn gearing compensation on or off.
GLOBALERROROUTPUT	Allows the user to specify a global error output which will be deactivated in the event of an error.
GO	To begin synchronized motion.
GROUP	To set or read whether a node is a member of a group.
GROUPCOMMS	To write to the comms arrays of all the nodes within a specified group.
GROUPMASTER	To set a node as the master of a group or to return the node ID of the group master.
GROUPMASTERSTATUS	To determine whether the current node is master of the group.
GROUPSTATUS	To determine whether the current node is a member of the group.
HELIXA	To load a helix move into the move buffer.
HELIXR	To load a helix move into the move buffer.
HOME	To find the home position on an axis.
HOMEBACKOFF	To set the home back-off speed factor.
HOMECREEPSPEED	To set the creep speed for homing moves.
HOMEINPUT	To set a digital input to be the home switch input for the specified axis.

Keyword	Description
HOMEPHASE	To find the phase of the homing sequence currently in progress.
HOMEPOS	To read the axis position at the completion of the homing sequence.
HOMESPEED	To set the speed for the initial seek phase of the homing sequence.
HOMESTATUS	To set or read the status of a homing sequence.
HOMESWITCH	To return the state of the home input.
HTA	Starts the hold to analog mode of motion.
HTACHANNEL	To specify the analog input to use for a particular axis while in Hold To Analog (HTA) mode.
HTADAMPING	Specifies the damping term used in the Hold To Analog (HTA) algorithm.
HTADEADBAND	Specifies the analog error deadband.
HTAFILTER	Sets the filter factor for the analog input.
HTAKINT	Specifies the integral gain term used in the Hold To Analog (HTA) force loop.
HTAKPROP	Specifies the proportional gain term used in the Hold To Analog (HTA) force loop.
IDLE	Indicates if a move has finished executing and the axis has finished moving.
IDLEMODE	To control the checks performed when determining if an axis idle.
IDLEPOS	Reads or sets the idle following error limit.
IDLESETTLINGTIME	To read the time taken for an axis to become idle.
IDLETIME	To specify the period for which the axis must meet its idle conditions before becoming idle.
IDLEVEL	Reads or sets the idle velocity limit.
IMASK	To mask off Mint events IN0 .. INx.
IN	To read the state of all the inputs on an input bank.
INCA	To set up an incremental move to an absolute position.
INCR	To set up an incremental move to a relative position.
INITERROR	To report any errors detected during start-up.
INITWARNING	Returns the sum of a bit pattern describing initialization warnings generated at start-up.
INPUTACTIVELEVEL	To set the active level on the digital inputs.
INPUTDEBOUNCE	To set or return the number of samples used to 'debounce' a digital input bank.

Keyword	Description
INPUTMODE	To set or return the sum of a bit pattern describing which of the user digital inputs should be edge or level triggered.
INPUTNEGTRIGGER	To set or return the user inputs that become active on negative edges.
INPUTPOSTRIGGER	To set or return the user inputs that become active on positive edges.
INSTATE	To read the state of all digital inputs.
INSTATEX	To read the state of an individual digital input.
INX	To read the state of an individual digital input.
JOG	To set an axis for speed control.
KACCEL	To set the servo loop acceleration feed forward gain.
KDERIV	To set the servo loop derivative gain on the servo axes.
KEYS	To remap the layout of the keys on a Baldor CAN KeypadNode.
KINT	To set the servo loop integral gain.
KINTLIMIT	To restrict the overall effect of the integral gain KINT.
KINTMODE	To control when integral action will be applied in the servo loop.
KNIFE	Loads a tangential knife move on the specified axis.
KNIFEAXIS	Specifies the master axis that the knife axis should follow.
KNIFEMODE	Specifies the knife mode with which moves on the knife master axis are loaded.
KNIFESTATUS	To read or set the status of the knife axis.
KPROP	To set the proportional gain for the position controller.
KVEL	To set the servo loop velocity feedback gain term.
KVELFF	To set the velocity feedforward term for the position controller.
LED	To set or read the display mode for the seven segment display.
LEDDISPLAY	To set or read the value for the seven segment display.
LIFETIME	To return a lifetime counter for the drive.
LIMIT	To return the state of the forward and reverse limit switch inputs for the given axis.
LIMITFORWARD	To return the state of the forward limit switch input for the given axis.
LIMITFORWARDINPUT	To set the user digital input configured to be the forward end of travel limit switch input for the specified axis.
LIMITMODE	To control the default action taken in the event of a forward or reverse hardware limit switch input becoming active.
LIMITREVERSE	To return the state of the reverse limit switch input for the given axis.

Keyword	Description
LIMITREVERSEINPUT	To set the user digital input configured to be the reverse end of travel limit switch input for the specified axis.
LOOPTIME	To set the servo loop update interval in microseconds.
MASTERCHANNEL	To set or read the channel of the input device used for gearing.
MASTERDISTANCE	To set the distance on the master axis over which the slave will travel for a 'segment' in master-slave move types.
MASTERSOURCE	To set or read the source of the input device used for gearing.
MAXSPEED	To set a limit for the speed demanded on an axis.
MISCERROR	To read or clear the miscellaneous error flag.
MISCERRORDISABLE	To enable or disable miscellaneous errors calling the error event.
MOVEA	To set up a positional move to an absolute position.
MOVEBUFFERFREE	To return the number of free spaces in the move buffer for the specified axis.
MOVEBUFFERID	To attach or read back a 16-bit identifier from the move buffer.
MOVEBUFFERIDLAST	To read a 16-bit identifier from the move buffer.
MOVEBUFFERLOW	To set or return the number of free spaces in the move buffer before a move buffer low event is generated.
MOVEBUFFERSIZE	To set or return the size of the move buffer allocated on the specified axis.
MOVEBUFFERSTATUS	To return information about the move buffer.
MOVEDWELL	To load a dwell move into the move buffer.
MOVEOUT	To load a digital output bit pattern into the move buffer.
MOVEOUTX	To load a change of state for a specific digital output into the move buffer.
MOVEPULSEOUTX	To load a pulsed change of state for a specific digital output into the move buffer.
MOVER	To set up a positional move to a relative position.
NODE	To set or read the node ID used by this node.
NODELIVE	To determine if a CAN node on the bus is currently live or dead.
NODESCAN	To scan a specific CAN bus for the presence of a specific node.
NODETYPE	To add or remove a CAN node to/from the CAN network. Can also be read to determine the node type.
NUMBEROF	To return information about the abilities of the controller.
NVFLOAT	To read or write a floating point value in non-volatile memory.
NVLONG	To read or write a long integer value in non-volatile memory.

Keyword	Description
NVRAMDEFAULT	Clears the contents of non-volatile RAM (NVRAM).
OFFSET	To perform a positional offset move.
OFFSETMODE	Define the mode of operation on the OFFSET keyword.
OUT	To set or read the state of all the outputs on an output bank.
OUTPUTACTIVELEVEL	To set the active level on the digital outputs.
OUTX	To set or read an individual digital output.
PLATFORM	To return the platform type.
POS	To set or read the current axis position.
POSDEMAND	To set or read the instantaneous position demand.
POSREMAINING	To indicate the remaining move distance.
POSROLLOVER	To count the number of wraps of the axis position value.
POSROLLOVERDEMAND	To return the number of position wraps required by the current move.
POSTARGET	Reads the target position of the current positional move.
POSTARGETLAST	Reads the target position of the last move in the move buffer.
PRECISIONINCREMENT	Sets or reads the theoretical distance between each of the values in the leadscrew compensation tables.
PRECISIONMODE	Controls the action of leadscrew compensation.
PRECISIONOFFSET	Sets the distance between the start of the leadscrew and axis zero position.
PRECISIONTABLE	Loads the leadscrew compensation tables.
PRODUCTPOWERCYCLES	To return the number of times the controller has been power cycled.
PRODUCTSERIALNUMBER	To return the serial number of the controller.
PROFILEMODE	To select the type of velocity profiler to use.
PROFILETIME	To set the profiler update rate.
PULSEOUTX	To activate a digital output for a specified number of milliseconds.
RELAY	To enable or disable the relay.
REMOTEADC	To read the value of a remote analog input (ADC).
REMOTEADCDELTA	To control the rate of change on a remote analog input before a REMOTEADC message is sent.
REMOTEBAUD	To specify the CAN baud rate of a remote Baldor CAN node (I/O or Keypad).
REMOTEDAC	To control the value of a remote analog output channel (DAC).
REMOTEDEBOUNCE	To control the number of samples used to 'debounce' an input on a remote CAN node.

Keyword	Description
REMOTEEMERGENCY-MESSAGE	Returns the error code from the last emergency message received from a particular CANopen node.
REMOTEERROR	Reads the CANopen error register information reported within the last emergency message received from a specific node.
REMOTEESTOP	To control the emergency stop state of a remote CAN node.
REMOTEIN	To read the state of all the digital inputs on a remote CAN node.
REMOTEINBANK	To read the state of a bank of digital inputs on a remote CAN node.
REMOTEINHIBITTIME	To set or read the CANopen PDO inhibit time.
REMOTEINPUT-ACTIVELEVEL	To control the active state of digital inputs on a remote CAN node.
REMOTEINX	To read the state of individual digital inputs from a remote CAN node.
REMOTEMODE	To control the update mode for a remote node.
REMOTENODE	To specify the node ID of a remote Baldor CAN node (I/O or Keypad).
REMOTEOBJECT	To access the Object Dictionary of any CANopen node present on the network.
REMOTEOBJECTSTRING	To access 'Vis-String' entries in the Object Dictionary of any CANopen node present on the network.
REMOTEOUT	To control the state of digital outputs on a remote CAN node.
REMOTEOUTBANK	To read the state of a bank of digital outputs on a remote CAN node.
REMOTEOUTPUT-ACTIVELEVEL	To control the active state of digital outputs on a remote CAN node.
REMOTEOUTPUTERROR	To read or reset the digital outputs that are in error on a remote Baldor CAN node.
REMOTEOUTX	To control the state of individual digital outputs on a remote CAN node.
REMOTEPDOIN	To request data from a node in the form of a PDO message.
REMOTEPDOOUT	To force a Baldor controller node to transmit a variable length PDO message with a specific COB-ID. The PDO will contain up to 64 bits of data that can be passed in the form of two 32-bit values.
REMOTERESET	Force a remote CAN node to do a software reset.
REMOTESTATUS	To set or read the status register on a remote CAN node.
RESET	To clear motion errors, set the position to zero and re-enable the drive.

Keyword	Description
RESETALL	To perform a reset on all axes.
SCALEFACTOR	To scale axis encoder counts, or steps, into user defined units.
SERIALBAUD	To set the baud rate of the RS232 / RS485/422 port.
SOFTLIMITFORWARD	To set the forward software limit position on a specified axis.
SOFTLIMITMODE	To set or read the default action taken if a forward or reverse software limit position is exceeded.
SOFTLIMITREVERSE	To set or read the reverse software limit position on a specified axis.
SPEED	To set or read the slew speed of positional moves loaded in the move buffer.
SPLINE	To perform a spline move.
SPLINEEND	To define the end segment in the spline table for a spline move.
SPLINEINDEX	To read the currently executing spline segment number.
SPLINESEGMENT	To change spline table data.
SPLINESTART	To define the start segment in a spline table for a spline move.
SPLINESUSPENDTIME	To set the segment duration for a controlled stop during a spline move.
SPLINETABLE	To specify the array names to be used in a spline move on the specified axis.
SPLINETIME	To set the segment duration for all segments for a spline move.
STEPPERDELAY	To enforce a time delay between state changes on step and direction outputs.
STEPPERIO	Manually control the step and direction pins of a stepper channel.
STEPPERMODE	To make miscellaneous changes to the stepper channels.
STOP	To perform a controlled stop during motion.
STOPINPUT	To set or read the digital input to be used as the stop switch input for the specified axis.
STOPINPUTMODE	To set or read the action taken in the event of a stop input becoming active.
STOPSWITCH	To return the current state of the stop input for the axis.
SUSPEND	To pause the current move.
SYSTEMDEFAULTS	To reset parameter table entries to their default values and erase the Mint program, non-volatile RAM and error log.
SYSTEMSECONDS	To set or read a programmable system lifetime counter for the drive.

Keyword	Description
TERMINALADDRESS	To set or read the node ID for a CAN node associated with a terminal.
TERMINALDEVICE	To set or read the device type associated with a given terminal.
TERMINALMODE	To set or read handshaking modes for a terminal.
TERMINALPORT	To set or read the communication port associated with a given terminal.
TIMEREVENT	To set or read the rate of the timer event.
TORQUE	To execute torque control (constant current) on a servo axis.
TRIGGERCHANNEL	To specify the input used for triggering, when triggering on an axis source or encoder.
TRIGGERINPUT	To specify the input used for triggering, when triggering on a digital input.
TRIGGERMODE	Controls the triggering of a move.
TRIGGERSOURCE	To specify the source when axis triggering is using an axis/ encoder position.
TRIGGERVALUE	To specify an absolute value on which to trigger motion.
VECTORA	To perform an interpolated vector move on two or more axes with absolute co-ordinates.
VECTORR	To perform an interpolated vector move on two or more axes with relative co-ordinates.
VEL	To return the instantaneous axis velocity.
VELDEMAND	To read the current instantaneous demand velocity.
VELDEMANDPATH	To read the instantaneous demand velocity along the path of a multi-axis move.
VELFATAL	To set or read the threshold for the maximum difference between demand and actual velocity.
VELFATALMODE	To control the default action taken in the event of the velocity threshold being exceeded.

A

Abbreviations, 2-4

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